

ENGINEERING EVALUATION AND COST ANALYSIS (EE/CA)

SAMPLING PLAN

**Master Metals Site
Cleveland, Ohio**

EPA Region 5 Records Ctr.



200298

ENTACT



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Care*



Prepared for:

Master Metals Site Technical Committee

Prepared By:

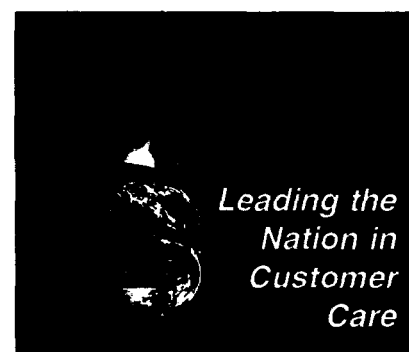
**ENTACT, Inc.
October 1, 1997**



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MASTER METALS SITE

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ENTACT

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1.0 Introduction

This document presents the Engineering Evaluation and Cost Analysis (EE/CA) Sampling Plan for the Master Metals, Inc. (MMI) site in Cleveland, Ohio. The EE/CA is being prepared by ENTACT Inc. (ENTACT) in response to the Administrative Order by Consent Pursuant to Section 106 of CERCLA (Administrative Order); issued on April 17, 1997 by the Environmental Protection Agency Region 5 (EPA). The EE/CA is being prepared pursuant to 40 C.F.R. 300.415(b)(4)(i), and the Superfund Accelerated Cleanup Model (SACM) guidance.

The Administrative Order requires a two-phased response action at the MMI site;

1. Phase I consists of the time-critical removal actions which commenced at the MMI site on June 9, 1997.
2. Phase II involves development and submission of an EE/CA Report to assess alternative response actions.

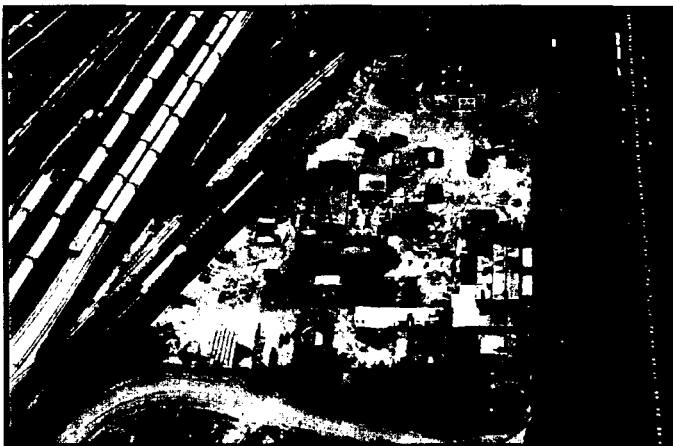
The Administrative Order Section V. 2. designates work to be performed. Sub-Section 2.2 of the Administrative Order requires the Phase II EE/CA Report in accordance with a scope of work (SOW)

attached to the Administrative Order. That SOW lists five tasks to be completed as part of the EE/CA process. This EE/CA Support Sampling Plan document is the second task required per the scope of work.

1.1 SCOPE OF EE/CA SUPPORT SAMPLING PLAN

This EE/CA Support Sampling Plan provides the following:

- ▶ Site Background
- ▶ Data Gap Description
- ▶ Sampling Procedures
- ▶ Project Organizational Chart and EE/CA
- ▶ Support Sampling Schedule
- ▶ Quality Assurance Project Plan provided as Appendix A
- ▶ XRF Standard Operating Procedure provided as Appendix B



Aerial view of the Master Metals Site prior to ENTACT activities



Master Metals Site During ENTACT activities, September 1997

2.0 Site Background

2.1 SITE DESCRIPTION

The Master Metals Site is located at 2850 West Third Street, Cleveland, Cuyahoga County, Ohio. The site consists of two contiguous parcels totaling approximately 4.3 acres. The MMI property is roughly a right triangle-shaped property with the southeast corner being the 90 degree angle. The site is bounded on the northwest by railyards owned by the Baltimore and Ohio railroad, on the south by a dead end road, and on the east by West Third Street. The site is enclosed by a ten foot chain link fence. The site is in a heavily industrialized area. LTV Steel owns the property to the north and south of the site.

The Cuyahoga River is approximately 0.5 miles east of the site and flows north toward Lake Erie. Topographic maps suggest that the direction of groundwater and surface water flow in the vicinity of the MMI site is to the northeast. The water table is at a depth of approximately ten feet below the ground surface.

Surface soils in the area are comprised of fill materials (cinders, slag, sand), and to a lesser extent, native soils (sand, silt, clay) deposited as glacial till or river alluvium. At the MMI site, concrete covers approximately 90 percent of the surface with fill materials, consisting of sand, cinders, slag, and gravel, covering the remaining surface areas.

The MMI facility is located on top of slag fill material that was reportedly deposited throughout the area during industrial development in the early 1900s. NL Industries, Inc. had operated at the site from 1932 to 1979. MMI purchased the site in 1979 and continued the existing site usage as a secondary lead smelter. The MMI facility ceased operations in 1993 after a history of environmental violations. The major features of the site included an office

building, numerous storage areas, two baghouses, and a deteriorated smelter building. In 1997, ENTACT began decontamination/demolition operations as part of a time-critical removal at the Master Metals site. All buildings except the office building have been razed. All remaining feedstock and debris materials have been either decontaminated and/or treated and shipped as either special waste or disposed as hazardous waste.

2.2 DATA COLLECTION ACTIVITIES

2.2.1 On-Site Sampling

Compliance Technologies, Inc. (CTI) conducted a Phase II environmental assessment of the MMI site in 1990. Thirty-four subsurface samples were collected and analyzed for eight RCRA metals (arsenic, barium, cadmium, chromium, lead, mercury, selenium, silver). Samples were collected from two to five feet in depth and eight to ten feet in depth. Results revealed lead concentrations which were 1-2 orders of magnitude higher than the other metals. Lead concentrations are shown in Figure 2-1. Slightly elevated concentrations of chromium and cadmium were observed in only 17 of the 34 samples.

In July, 1992, Ecology and Environment (on behalf of the U.S. EPA) collected seven surface samples on-site (SS1 - SS7). The lead results associated with this data collection effort shown in Figure 2-1. This investigation analyzed samples for the eight RCRA metals (arsenic, cadmium, chromium, lead, mercury, barium, silver, and selenium). Once again, lead values were 1-2 orders of magnitude higher than all other metals. Some results exhibited minor arsenic, barium, cadmium, and chromium concentrations, relative to lead concentrations.

As part of the time-critical removal, all exposed on-site surface areas (e.g., not covered by concrete) were excavated to a maximum depth of two feet or until slag fill material (e.g., slag, cinders, etc.) were encountered. XRF information collected from the excavations exhibited lead concentrations up to 39,000 ppm in the remaining slag fill material.

2.2.2 Off-Site Samples

In July 1992, Ecology and Environment (on behalf of U.S. EPA) collected samples proximate to the facility property to determine if the facility contaminants were subject to airborne transport. Analysis of these samples (SS8 - SS10) for RCRA metals showed total lead levels of 24,000 - 43,100 ppm (see Figure 2-1).

In July 1993, off-site surface samples were collected from locations 0.4 miles northwest and west of the site. These samples were collected near residential areas and indicated lead concentrations from 148 to 1,850 ppm.

2.2.3 Groundwater

In December 1990, Master Metals contracted with Compliance Technologies to install and sample four groundwater monitoring wells on the Master Metals site. Monitoring well locations can be found on Figure 2-1. Results of the sampling are as follows:

- ▶ The groundwater flows in a southerly direction beneath the site.
- ▶ Total metal concentrations in the groundwater ranged from 0.45 mg/L to 1.35 mg/L lead and 0.02 mg/L to 1.33 mg/L chromium with minor concentrations detected for cadmium, nickel and barium.
- ▶ The pH of the groundwater was between 6.80 and 9.86.

Groundwater is not used as a source of drinking water within a four mile radius of the MMI site. Lake Erie supplies the greater Cleveland area with its drinking water.

2.3 DATA GAPS

Based on previous sampling, the following information needs to be acquired to complete the informational data gaps which currently exist.

2.3.1 On-site samples

Figure 2-1 shows on-site samples collected during two historical MMI sample collection efforts. Three general areas of contamination exist based on previous subsurface investigations:

- 1) Non-concrete areas in the southeast corner of the property exhibited elevated levels of lead in borings B-10, B-11, B-12, B-13. This area exhibits the highest level of lead contamination at depth (11,175 mg/kg). This area along with the western boundary/railroad spur is also being excavated as part of Phase I time-critical activities.
- 2) The drum and container storage area exhibits moderate levels of lead contamination in borings B-07, B-08, and B-09 (up to 3,825 mg/kg at three feet).
- 3) The battery storage area shows elevated lead levels in borings B-24 through B-28 and B-30 (up to 14,070 mg/kg). The highest concentration, however, was collected from the one foot depth. This location has a high probability of surface cross-contamination because there was six inches of concrete to penetrate and this concrete surface was most probably highly contaminated with lead from battery breaking activities.

While elevated lead concentrations were detected in the drum/container and battery storage areas at a depth of approximately three to five feet, the lateral

extent has not been defined. Therefore, five supplemental borings will be installed to define the lateral extent of contamination which resides in these two areas. In addition, two borings will be installed adjacent to the furnace building basement to assess residual contamination which may exist at depth. All boring locations are shown on Figure 3-1.

Subsurface samples collected from the borings will be segmented into six-inch intervals for the upper one foot and one foot intervals thereafter. Each interval will be screened for total lead with the XRF. The first sample interval exhibiting XRF values less than 1000 mg/kg will be submitted to the laboratory for metal analysis (arsenic, cadmium, chromium, and lead).

2.3.2 Off-site samples

Off-site sample locations B-16, B-17, B-18, and B-19 were installed outside the south fence, B-20 was installed outside the west fence, and B-31 was installed to the northeast of the property. No lead contamination was found exceeding 229 mg/kg at these borings to a maximum depth of ten feet. However, no information was collected on any residual surface contamination which may exist based on surface lead deposition from air emissions.

Therefore, an XRF survey will be conducted around the perimeter of the facility to assess the potential for lead impacts. Once surface XRF values have been determined, one boring will be installed to approximately three feet on each side of the facility.

Subsurface samples collected from the borings will be segmented into six-inch intervals for the upper one foot and one foot intervals thereafter. Each sample interval will be screened with the XRF for total lead. The first sample interval exhibiting the XRF value below 1000 mg/kg will be submitted to the laboratory for metal analysis (arsenic, cadmium, chromium, and lead). All boring locations are shown on Figure 3-1.

In addition, off-site surface sampling will be conducted on Quigley Avenue (west of the site) to determine if Master Metals operations could have impacted the residential neighborhood located 0.4 miles to the northwest. Based on the report "Lead Monitoring Study Around Master Metals Inc. and LTV Steel Company" (Mark Conti, USEPA, January 1996), two observations can be made:

The wind rose indicates that the wind blows to the northwest only 2-4% of the time.

The report shows that 90 percent of the emissions decrease within 0.25 miles of the site.

Therefore, ENTACT will collect a maximum of nine samples along Quigley Ave. The approximate location of the samples is shown on Figure 3-2. The exact location and numbers of samples will be dependent on the ability to locate areas along Quigley Ave. which have not been impacted by any industrial operations. Ideally, three samples should be collected to the southwest of the site, three samples to the west of the site, and three samples to the northwest of the site. These samples will be collected at the 0-3" depth. All samples will be sent to the laboratory for analysis of total lead.

2.3.3 Groundwater

CTI installed four monitoring wells and collected groundwater samples for laboratory analysis of total RCRA metals in 1991. The CTI well locations are shown on Figure 2-1. Based on the information presented in the EE/CA sampling plan, U.S. EPA has agreed that groundwater in the area of MMI will not be source of drinking water in the future. However, U.S. EPA has requested that groundwater sampling of the wells be conducted to assess current metal concentrations, if the wells are still present at MMI.

ENTACT will conduct a survey in an attempt to locate the CTI wells. In the event that the wells are located, groundwater samples will be located and

analyzed for total and dissolved metal concentrations to:

- 1) assess the current metal concentrations in the saturated zone, and,
- 2) determine the metal concentrations in the dissolved state.

The groundwater will be analyzed for arsenic, cadmium, chromium, and lead.

If the on-site wells are no longer present, new groundwater wells will not be installed and the groundwater will not be sampled.

2.3.4 On-site Sump Investigation

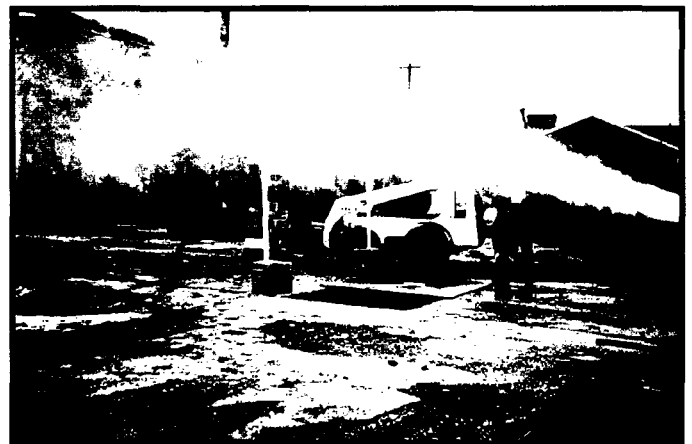
There are several surface sewer covers on the MMI property. ENTACT sealed any sewer covers on the property prior to beginning any Phase I demolition. However, Doug Mickey, current site owner, was in the process of installing a sump configuration around the property to collect sediment and allow stormwater and other liquids to flow to one central sump location.

Figure 2-2 shows the location of sumps and sewers at MMI. ENTACT performed site reconnaissance upon mobilization and found approximately thirteen square sumps: two in the furnace building, two in the battery breaking area, and nine around the old baghouse and white metals building. In addition, there is a circular sump in the southwest corner of the small sheet metal building. This building was the waste treat-

ment building; it received flow from the lift station/equalization tank.

There are approximately eight round sewer drains or covers on the site; one is located near the roundhouse, four in and around the safety zone, one in the storage building, one in the loading dock ramp, and one near the sump in the south central portion of the site. In addition, there is a garage drain in the safety zone. The condition of these sewers and sumps is unknown. As part of the time-critical removal, ENTACT will be pumping out the sumps, removing and treating (as necessary) the residue from the sumps. In addition, the sumps will be assessed during Phase I to determine the integrity of the system.

In addition, ENTACT is proposing a subsurface video investigation of these sumps (where possible) and associated piping as part of this EE/CA sampling plan to confirm the direction and condition of the on-site piping system.



On-site sump at the Master Metals Site

Figure 2-1
HISTORICAL SOIL SAMPLING LOCATIONS

ENTACT
October 1, 1991

Sample Type	Location ID	Boring Depth	Total Pb Result (ppm) & Sample Depth (Ft.)
Slag	B-1	Refusal @ 4'	23 (2-3')
Slag	B-2	Refusal @ 4.5'	28 (2-3')
Slag	B-3	Refusal @ 5'	38 (2-3')
Slag	B-4	Refusal @ 5'	36 (2-3')
Brown Sand/Brick	B-5	6" Concrete 10' Sand/Fill	17 (2-3') 18 (8-10')
Slag	B-6	8" Concrete - Refusal @ 4.5'	40 (2-3') 32 (4-5')
Slag	B-7	6" Concrete Refusal @ 5'	2,625 (3')
Slag	B-8	4" Concrete Refusal @ 6'	1,400 (3')
Slag	B-9	4" Concrete Refusal @ 5'	3,825 (3')
Sand/Brick	B-10	12'	970 (3-5') 11,825 (8-10')
Sand/Silty Clay	B-11	10'	11,175 (3-5') 3,500 (8-10')
Sand/Clay	B-12	10'	52 (3-5') 1,200 (8-10')
Sand	B-13	6" Concrete 10'	975 (3-5') 650 (8-10')
Sand/Silty Clay	B-14	6" Concrete 10'	125 (3-5') 105 (8-10')
Sand	B-15	8" Concrete 10'	500 (3-5') 166 (8-10')
Sand/Silty Clay	B-16	10'	15 (3-5') 8 (8-10')
Sand/Silty Clay	B-17	10'	18 (3-5') 33 (8-10')
Sand/Silty Clay	B-18	10'	22 (3-5') 15 (8-10')
Sand/Silty Clay	B-19	10'	128 (3-5') 63 (8-10')
Slag	B-20	Refusal @ 5'	55 (4')
Slag	B-21	4" Concrete 10'	102 (8-10')
Slag	B-22	4" Concrete Refusal @ 5'	352 (3-5')
Slag	B-23	4" Concrete Refusal @ 1.5'	No Information Available
Slag	B-24	6" Concrete Refusal @ 2.5'	4,960 (2')
Sand/Silty Clay	B-25	6" Concrete 10'	5,010 (3-5') 650 (8-10')
Slag	B-26	8" Concrete Refusal @ 7'	1,120 (3-5')
Sand	B-27	6" Concrete Refusal @ 1.5'	14,070 (1')
Slag	B-28	6" Concrete Refusal @ 5'	1,300 (4-5')
Slag/Sand	B-29	6" Concrete Refusal @ 5'	225 (3-5')
Slag/Coal	B-30	6" Concrete 10'	1,260 (3-5') 32 (8-10')
Slag	B-31	Refusal @ 5'	229 (5')
Trench Drain Sediment	SS1	Near Surface	115,000 + TCLP 1,230
Trench Drain Sediment	SS2	Near Surface	8,610 + TCLP 1,040
Surface Soil	SS3	Near Surface	98,000 + TCLP 1,220
Surface Soil	SS4	Near Surface	6,020 + TCLP 3.3
Low Area Sediment	SS5	Near Surface	78,340 + TCLP 959
Surface Soil	SS6	Near Surface	94,000 + TCLP 1,060
Surface Soil	SS7	Near Surface	107,000 + TCLP 1,260
Surface Soil	SS8	Near Surface	24,000 + TCLP 6.3
Surface Soil	SS9	Near Surface	24,200 + TCLP 6.3
Surface Soil	SS10	Near Surface	43,100 + TCLP 757

NOTES:

- Site Plan Not To Scale
- Site Features And Boring Locations are Approximate

LEGEND

- Boring Location - CTE, 1990
- Boring Location Monitoring Well - CTE, 1990
- Surface Grid Sample Location - E & E, 1992
- - - Fence
- ||||| Railroad Tracks

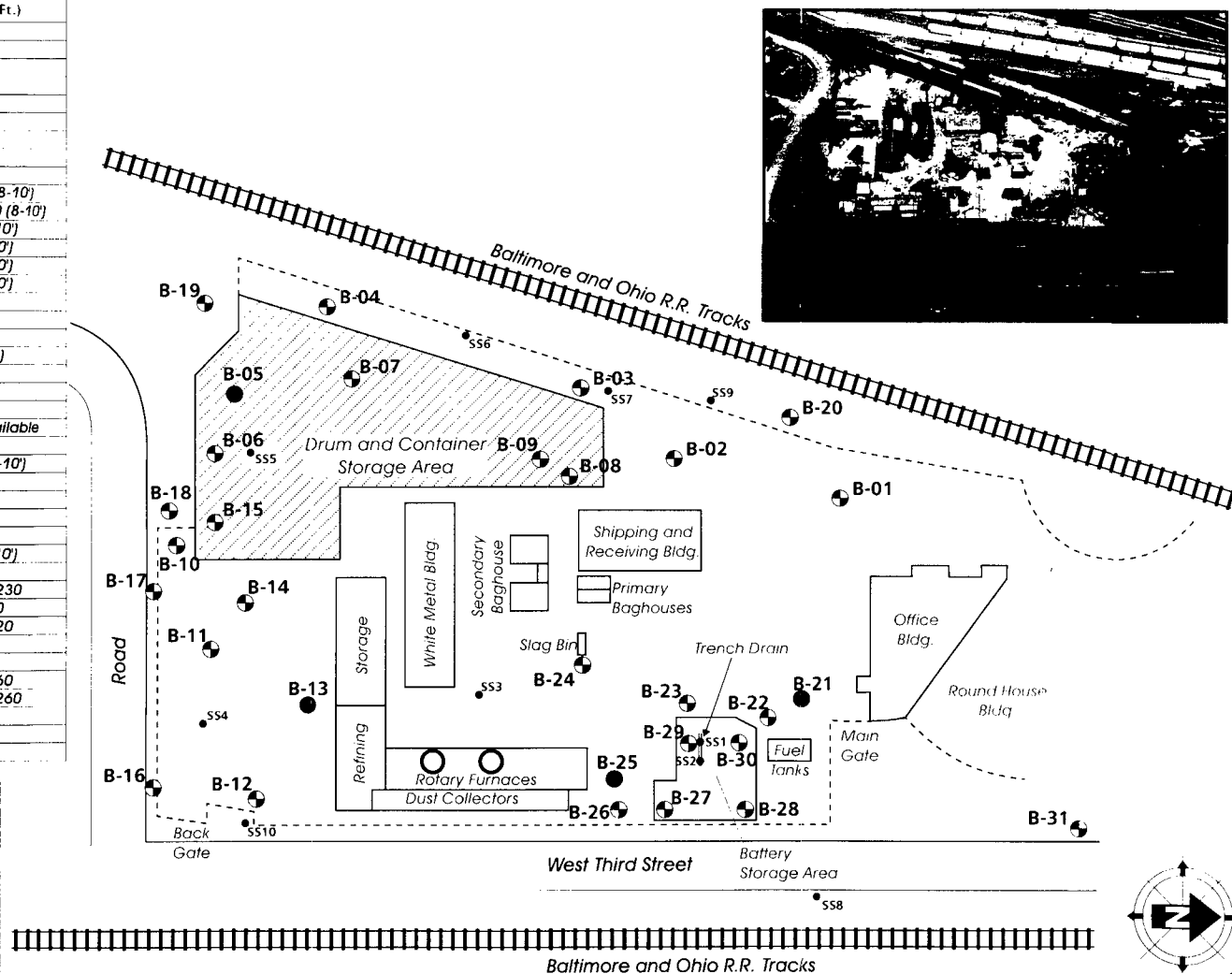
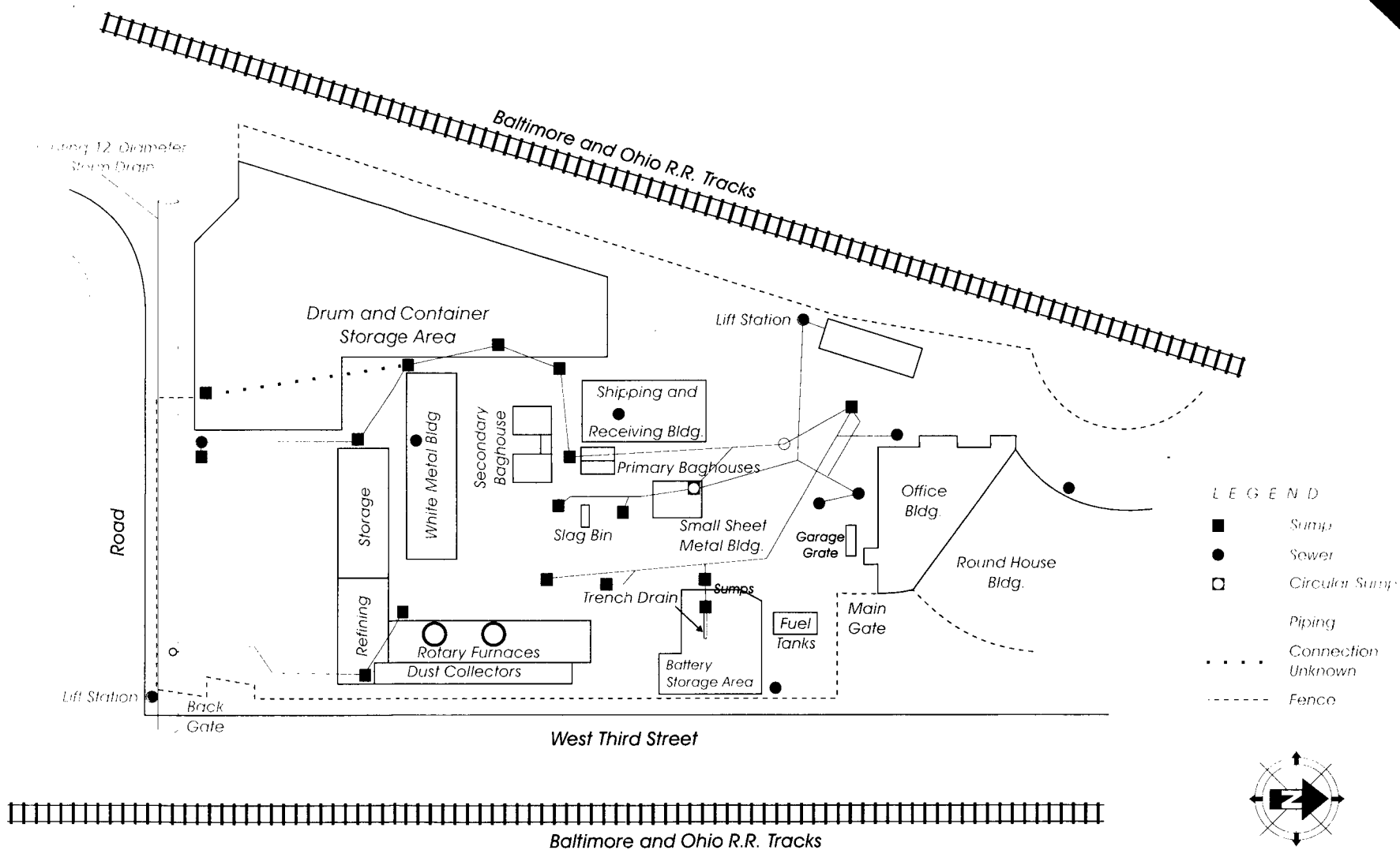


Figure 2-2
SEWER AND SUMP LOCATIONS

ENTACT
 October 1, 1997



3.0 Sampling and Analysis Procedures

3.1 Statement of Objectives

This Extent of Contamination (EOC) Sampling and Analysis Plan provides the procedures and methods to determine the extent of on-site and off-site soil lead impacts at the Master Metals Site. Quality assurance (QA) and quality control (QC) procedures are presented in the Quality Assurance Project Plan (QAPP) in Appendix A.

Based on process knowledge and historical sampling at Master Metals, lead is the primary metal of concern. Therefore, lead will be the primary metal screening constituent for this EE/CA sampling investigation. ENTACT will obtain field XRF screening values on the site perimeter to determine the impact of total lead. From the XRF results, borings will be installed and samples selected for laboratory analysis. The samples will be collected to a maximum depth of three feet to assess perimeter lead impacts around the facility.

On-site sampling will be conducted by installing borings and collecting samples to assess lateral extent of contamination (EOC) from the drum storage and battery storage areas. Lastly, surface samples will be collected along Quigley Ave. to assess the potential for lead impact of air emissions from Master Metals operations.

3.2 Sample Identification System

A sample identification system will be implemented in order to properly track sampling activities. The sampling activities and examples of the identification coding system associated with each type are listed below with a following explanation:

3.2.1 Soil Samples

The soil samples will be identified with a three component identification as follows:

1) A two to three digit location designation;

X	-	XRF Field Screening
ONS	-	On-Site Solid Media
PS	-	Perimeter Solid Media
OS	-	Off-Site Solid Media

2) The consecutive sample number collected in the area.

3) Borings will have another two digit field representing the depth of the sample (in inches).

For example, ONS-01-06 represents the first sample collected from on-site at a depth of 6 inches.

X-Ray Fluorescence (XRF) extent of contamination samples will be numbered and incorporated into the XRF's electronic database. The samples will be numbered with the consecutive number and the sampled depth interval from ground surface.

3.2.2 Groundwater Samples

The four groundwater sampling wells will have be designated MW and will be numbered consecutively with a two digit designation. Therefore, the first groundwater sample will be designated MW-01.

3.2.3 Quality Control Samples

Field Rinsate Blanks FB-000

All numbering sequences shown above for the quality control samples with "000" will begin with the number "001" and will continue upward by one unit (i.e., FB-001, FB-002, FB-003, etc.) until the final samples for the EOC are collected.

3.3 Solid Media Sampling Procedures

3.3.1 Surface Solid Media Sampling

The solid media sampling locations are shown on Figure 3-1 for the Master Metals Site. There are 17 surface XRF sampling locations around the perimeter of the Master Metals facility.

a. The sampling team will adhere to health and safety protocols defined in the Health and Safety Plan. Disposable vinyl gloves will be worn by sampling personnel at all times.



ENTACT sampling activities

b. Designated sampling locations will be identified. Photographs and/or a video record will be maintained to document sample locations.

c. Staging areas for sample collection will be established. Vegetation will be cut back where necessary to facilitate access to needed sample locations. Polyethylene sheeting will be placed adjacent to the areas to be sampled during sample collection.

The following tools and supplies will be prepared for use:

- ▶Field Logbook;
- ▶Plastic or glass laboratory-supplied sample containers;

- ▶Stainless steel or plastic disposable trowels and knives;
- ▶Disposable sample gloves;
- ▶Clean buckets to hold equipment;
- ▶Plastic sheeting and/or sample prep boards;
- ▶Stainless steel or plastic bowls;
- ▶Steel tube sampler and liners;
- ▶Measuring tape;
- ▶Non-phosphate detergent;
- ▶Distilled water; and
- ▶3 - 5 gallon buckets and brushes for decontamination liquids.

d. Surface solid media samples will be collected using decontaminated sample trowels.

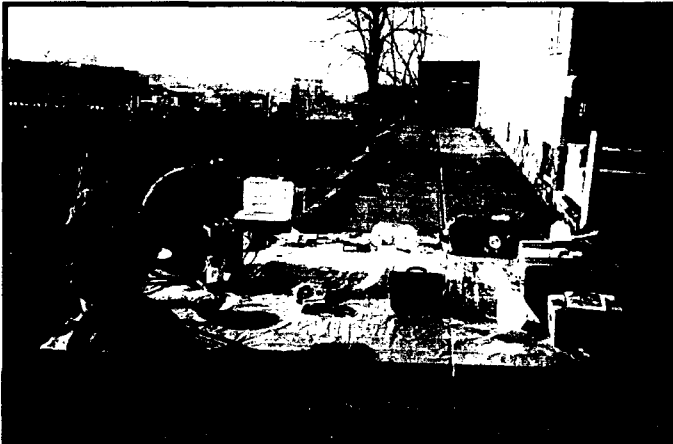
e. Each pre-determined sample will be placed in a sample bowl and homogenized.

f. The homogenized sample will be placed on a clean surface and the XRF will be placed directly onto the solid media sample. A measurement of the total lead concentration will be recorded for that interval. All XRF screening results will be conducted in triplicate and all results above the Spectrace 9000 quantitation limit will be reported. For samples which do not require XRF, the samples will be placed directly into laboratory containers.

g. Field notes will be recorded and a description of the material sample will include color, composition, and other pertinent information. The materials will be temporarily stored in plastic bags and labeled in accordance with the sample identification system for subsequent assessment and packaging for laboratory analysis.

3.3.2 Subsurface Solid Media Sampling

Subsurface solid media sampling will primarily be performed by utilizing a hydraulically driven, decontaminated sample tube device. Solid media samples will be obtained as follows:



ENTACT sampling activities

- a. The sampling team will adhere to health and safety protocols defined in the Health and Safety Plan. Disposable vinyl gloves will be worn by sampling personnel at all times.
- b. Utility line locates will have been performed for each area before installation of boreholes.
- c. Designated sampling locations will be identified. Photographs and/or a video record will be maintained to document sample locations. Any necessary concrete coring will have been previously performed.
- d. Staging areas for sample collection will be established. Vegetation will be cut back where necessary to facilitate access to needed sample locations. Polyethylene sheeting will be placed adjacent to the areas to be sampled during sample collection.

The following tools and supplies will be prepared for use:

- ▶Field Logbook;
- ▶Plastic or glass laboratory-supplied sample containers;
- ▶Stainless steel or plastic disposable trowels and knives;
- ▶Disposable sample gloves;
- ▶Clean buckets to hold equipment;

- ▶Plastic sheeting and/or sample prep boards;
- ▶Stainless steel or plastic bowls;
- ▶Steel tube sampler and liners;
- ▶Measuring tape;
- ▶Non-phosphate detergent;
- ▶Distilled water; and
- ▶3 - 5 gallon buckets and brushes for decontamination liquids.

- e. Subsurface samples will be collected using the steel sample tube equipped with an interior cellulose or acetate liner. The sample tube will be hydraulically driven to the desired depth and retracted from the boring.
- f. The liner containing the sample will be removed from the sample tube and placed on plastic sheeting. The liner will be sectioned into the pre-determined sample intervals with a clean sample knife.
- g. Each pre-determined sample interval will be placed in a sample bowl and homogenized.
- h. The homogenized sample will be placed on a clean surface and the XRF will be placed directly onto the solid media sample. A measurement of the total lead concentration will be recorded for that interval. All XRF screening results will be conducted in triplicate and all results above the Spectrace 9000 quantitation limit will be reported.
- i. Field notes will be recorded and a description of the material sample will include color, composition, and other pertinent information. The materials will be temporarily stored in plastic bags and labeled in accordance with the sample identification system for subsequent assessment and packaging for laboratory analysis.
- j. Repeat steps e through i until the full sampling depth has been obtained.

3.3.3. Laboratory Samples

Following XRF field screening, XRF values for each sample interval will be assessed and the first sample interval which exhibits a lead concentration lower than 1000 mg/kg, will be selected for laboratory analysis.

- a. In each case, a sufficient amount of sample will be obtained by decontaminated sample trowel to fill a laboratory-supplied sample container.
- b. Chain-of-custody documents will be prepared. Sample containers will be labeled in accordance with the predetermined sample numbering system, and the sample placed into a container for shipment to the laboratory for analysis.
- c. All sampling equipment contacting the soil will be decontaminated utilizing a detergent wash and potable water rinse, followed by a distilled water rinse and drying with disposable towels between each sampling event.
- d. Borings will be backfilled with the original soil. Excess soil will be containerized in appropriately labeled drums and temporarily stored at the facility. All EOC samples submitted to the laboratory will be analyzed for total lead, arsenic, cadmium, and chromium. Table 3-1 contains a listing of laboratory test methods to be utilized, notes regarding handling and/or sample containers and amount of sample material to be collected.

3.4 Groundwater Sampling Procedures

In the event that the four (4) monitoring wells installed during the 1990 CTI investigation are located, groundwater samples will be collected. Additionally, water level measurement collected from each well will be used to determine the groundwater flow direction and horizontal gradient.

Water level measurements will be recorded from the 4 wells prior to purging the wells for sampling purposes. Depth to water measurements will be subtracted from the top of casing elevations to obtain the water level elevations. Total depth of each well will also be measured each time water levels are recorded. All well measurements will be taken with a weighted steel tape or electronic probe to the nearest 0.01 feet.

Before sampling, three well volumes of groundwater will be purged from each well, unless the well is purged dry. Temperature, pH, and specific conductance will be measured following removal of each well volume to verify that a representative groundwater sample is collected. If a well is purged dry before three well volumes can be removed, purging will cease and the well will be allowed to recover. As soon as there is a sufficient volume of water in the well, a groundwater sample will be collected for laboratory analysis. Groundwater samples from the monitoring wells will be laboratory analyzed for total and dissolved arsenic, cadmium, chromium, and lead.

Purging and sampling of the wells will be accomplished using a bottom-loading, disposable, polyvinyl chloride (PVC) bailer and purge water will be collected in a designated container. Disposable nitrile gloves will be worn by all sampling personnel and changed after each sample is obtained. Field notes will be completed and will include a description of the well being sampled, water color before and after purging and all field measurements. Groundwater samples for dissolved metal analyses will be field filtered and transferred directly into laboratory-supplied containers. Samples will be labeled in accordance with the predetermined coding system, sealed in plastic bags and placed on ice in an insulated cooler for shipment to the laboratory. Chain-of-custody documents will be prepared and will accompany the samples during shipment to the laboratory for analysis.

All non-dedicated sampling equipment will be decontaminated utilizing a detergent wash and potable water rinse, followed by a distilled water rinse and drying with disposable towels between each sampling event. All disposable sampling media will be placed into designated site containers.

3.5 Quality Control Samples

Field QC Samples

During the course of field sampling QC samples will be collected to ensure that cross-contamination of samples did not occur from improperly cleaned equipment or to ensure repeatability of laboratory analysis. These QC samples are:

Equipment rinsate blanks

An equipment rinsate blank will be submitted for every twenty soil samples collected. The rinsate blank will be prepared by pouring distilled water through a decontaminated sampling device and then collected in a water sample container with nitric acid preservative. The rinsate blank will be analyzed for arsenic, cadmium, chromium, and lead. The purpose of the rinsate blank is to evaluate potential cross-contamination of samples resulting from decontamination activities.

3.6 Documentation and Use of Field Logbook

Field logbooks will provide the documentary evidence for procedures as performed by field personnel. Each entry should be legible and contain accurate and complete field documentation of specific activities. The logbook should contain only facts and observations. Each logbook page should be numbered, dated, and signed by all personnel making entries on that page. Under no circumstances will pages be removed from the logbook. General information that should be documented in the field logbook(s) includes, but is not limited to the following:

- ▶The objective(s) of the daily activities.
- ▶Identification of sampling teams, major equipment used, procedures followed, and weather conditions.
- ▶Notation of time and chronological summary of field activities and events.
- ▶Signatures of individuals making entries.
- ▶Specific information that should be documented in the field logbook includes, but is not limited to:
 - Sampling data, sample descriptions, sample locations, references, and labeling described for specific activities for sampling and chain-of-custody procedures.
 - Results of measurements and calibration of field instruments used.
 - Detailed description of health and safety related activities at the site.

3.7 Data Quality Objectives

Data quality objectives (DQOs) are qualitative and quantitative statements specified to ensure that data of known and appropriate quality are obtained during the EOC. DQOs provide a clear definition of the objectives and the method by which decisions will be made. DQOs are developed using the following three-stage process:

Stage 1 - Identify decision types

Stage 2 - Identify data uses and needs

Stage 3 - Design data collection program

The structure of this sampling plan and Quality Assurance Project Plan (QAPP) have complied with

3.10 Field Instrument Operation and Calibration

X-Ray Fluorescence Analyzer

The Spectrace 9000 energy dispersive X-Ray Fluorescence analyzer will be the instrument utilized for EOC investigation. The Spectrace 9000 utilizes three radioisotope sources. Each source emits a different energy (wavelength) of radiation which provides efficient analysis of specific ranges of elements. A 1-3 minute scan time will be utilized for the duration of the EOC investigation. Only qualified analysts trained in the proper use, theory, and safety of XRF analysis will operate this system.



ENTACT XRF field calibration activities

The principle of XRF analysis is based on electron excitation. Elemental atoms in a soil sample are irradiated with a beam of X-Rays. Electrons in the atom at lower lying energy levels are excited to higher energy levels. The vacancies left in the inner electron orbitals make the atom unstable. Relaxation to the ground state occurs, resulting in the emission of X-Rays characteristic of the excited elements. Thus, by examining the energies of the X-Rays emitted by

the irradiated soil sample, identification of elements present in the sample is possible.

Comparing the intensities of the X-Rays emitted from a given sample to those emitted from reference standards with known analyte concentrations allows quantitation of the elements present in the samples. During on-site activities, the XRF will be standardized daily utilizing referenced standards for quality assurance and quality control.

The XRF will be operated in accordance with the XRF SOP presented in Appendix B. The XRF will be standardized using a minimum of three site-specific soils obtained from the facility. These site-specific standards will be assayed in the laboratory and will reflect the levels of lead concentrations to be found on the Master Metals Site.

The XRF will be standardized at the beginning of the day and at the end of the day with each site-specific standard. In addition, the mid range standard will be verified every 20 samples to confirm the instrument is functioning properly. The measurement time for each standard and sample will be approximately 1-3 minutes. Each sample interval (surface or core) will involve taking triplicate measurements using the XRF and averaging them.

3.11 Analytical Laboratory

National Environmental Testing laboratories (NET), Bartlett, Illinois is the laboratory for all analytical testing. ENTACT will engage NET for the analysis of solid media and groundwater samples. A copy of the NET Statement of Qualification (SOQ) is available upon request.

Table 3-1: List of EE/CA Parameters for Master Metals Site

Test Description	Test Method	Extraction Method	Matrix	Frequency	Container	Preservative	Sample Size	Maximum Holding Time	Reporting Limit (mg/kg)
Total Lead	XRF	NA	solid	every 6" for one foot; every foot thereafter	Field Test	NA	NA	NA	NA
Total Lead	SW-6010	SW-3050	solid	1 per boring location	P/G	None	100 g	6 months	4.0
Total Arsenic	SW-6010	SW-3050	solid	1 per boring location	P/G	None	100 g	6 months	10
Total Cadmium	SW-6010	SW-3050	solid	1 per boring location	P/G	None	100 g	6 months	0.25
Total Chromium	SW-6010	SW-3050	solid	1 per boring location	P/G	None	100 g	6 months	0.5
Dissolved Lead	SW-7421	SW-3050	water	1 per monitoring well	P/G	pH <2, Cool 4 C	100 g	6 months	0.005
Dissolved Arsenic	SW-7060	SW-3050	water	1 per monitoring well	P/G	pH <2, Cool 4 C	100 g	6 months	0.005
Dissolved Cadmium	SW-6010	SW-3050	water	1 per monitoring well	P/G	pH <2, Cool 4 C	100 g	6 months	0.005
Dissolved Chromium	SW-6010	SW-3050	water	1 per monitoring well	P/G	pH <2, Cool 4 C	100 g	6 months	0.01
Total Lead	SW-7421	SW-3050	water	1 per monitoring well	P/G	pH <2, Cool 4 C	100 g	6 months	0.005
Total Arsenic	SW-7060	SW-3050	water	1 per monitoring well	P/G	pH <2, Cool 4 C	100 g	6 months	0.005
Total Cadmium	SW-6010	SW-3050	water	1 per monitoring well	P/G	pH <2, Cool 4 C	100 g	6 months	0.005

Table 3-1: List of EE/CA Parameters for Master Metals Site

Test Description	Test Method	Extraction Method	Matrix	Frequency	Container	Preservative	Sample Size	Maximum Holding Time	Reporting Limit (mg/kg)
Total Chromium	SW-6010	SW-3050	water	1 per monitoring well	P/G	pH <2, Cool 4 C	100 g	6 months	0.01

NOTES:

Sample Test Method designated as SW-xxxx is from EPA SW-846

P/G - Plastic or Glass

XRF - X-Ray Fluorescence Analyzer

NA - Not Applicable

TABLE 3-2: List of Data Quality Assurance Objectives for
the EE/CA at Master Metals, Cleveland, Ohio

Test Description	Test Method	Extraction Method	Matrix	Reporting Limit ⁽¹⁾	Precision (%RPD) ⁽²⁾	Accuracy (% Recovery)	Completeness
Total Arsenic	SW-6010 ⁽³⁾	SW-3050	Solid	10 mg/kg	0 - 20	80 - 120	90%
Total Cadmium	SW-6010	SW-3050	Solid	0.25 mg/kg	0 - 20	80 - 120	90%
<u>Total Chromium</u>	<u>SW-6010</u>	<u>SW-3050</u>	<u>Solid</u>	<u>0.5 mg/kg</u>	<u>0 - 20</u>	<u>80 - 120</u>	<u>90%</u>
Total Lead	SW-6010	SW-3050	Solid	4.0 mg/kg	0 - 20	80 - 120	90%
Total Arsenic	SW-7060	SW-3050	Water	0.005 mg/L	0 - 20	80 - 120	90%
Total Cadmium	SW-6010	SW-3050	Water	0.005 mg/L	0 - 20	80 - 120	90%
<u>Total Chromium</u>	<u>SW-6010</u>	<u>SW-3050</u>	Water	0.01 mg/L	0 - 20	80 - 120	90%
Total Lead	SW-7421	SW-3050	Water	0.005 mg/L	0 - 20	80 - 120	90%
Dissolved Arsenic	SW-7060	SW-3050	Water	0.005 mg/L	0 - 20	80 - 120	90%
Dissolved Cadmium	SW-6010	SW-3050	Water	0.005 mg/L	0 - 20	80 - 120	90%
<u>Dissolved Chromium</u>	<u>SW-6010</u>	<u>SW-3050</u>	Water	0.01 mg/L	0 - 20	80 - 120	90%
Dissolved Lead	SW-7421	SW-3050	Water	0.005 mg/L	0 - 20	80 - 120	90%

Notes:

⁽¹⁾ Reporting limits listed are specific for instrument and analyst and are based on minimal matrix interference. Actual reporting limits may vary depending due to sample matrix, sample dilution, or changes in instrument and/or analyst.

⁽²⁾ %RPD - Relative percent difference.

⁽³⁾ Sample test method designated as SW-xxxx is from EPA SW-846.

TABLE 3-3

SUMMARY TABLE OF SAMPLING AND ANALYSIS PROGRAM FOR EE/CA INVESTIGATION
MASTER METALS, CLEVELAND, OHIO

Sample Type	Analysis Parameters	Field Quality Control Samples												
		Investigative Samples			Field Duplicates ²			Field Blanks			MS/MSD ¹			
		No. ⁴	Freq.	Total	No.	Freq.	Total	No.	Freq.	Total	No.	Freq.	Total	Total
On-Site Samples	Field - - XRF Survey	28	1	28	--	--	--	--	--	--	--	--	--	28
	Laboratory ---- Total Metals ³	7	1	7	1	1	1	1	1	1	--	--	--	7
Perimeter Samples	Field - - XRF Survey	33	1	33	--	--	--	--	--	--	--	--	--	33
	Laboratory ---- Total Metals	4	1	4	1	1	1	1	1	1	--	--	--	6
Off-Site Samples	Laboratory ---- Total Metals	9	1	9	1	1	1	1	1	1	--	--	--	11
Water	Laboratory ---- Total Metals	4	1	4	1	1	1	1	1	1	--	--	--	6
	Laboratory --- Dissolved Metals	4	1	4	1	1	1	1	1	1	--	--	--	6

¹For metals analysis, no extra sample volume is required; MS/MSD will be performed at a rate of one per twenty investigative samples analyzed by the laboratory.

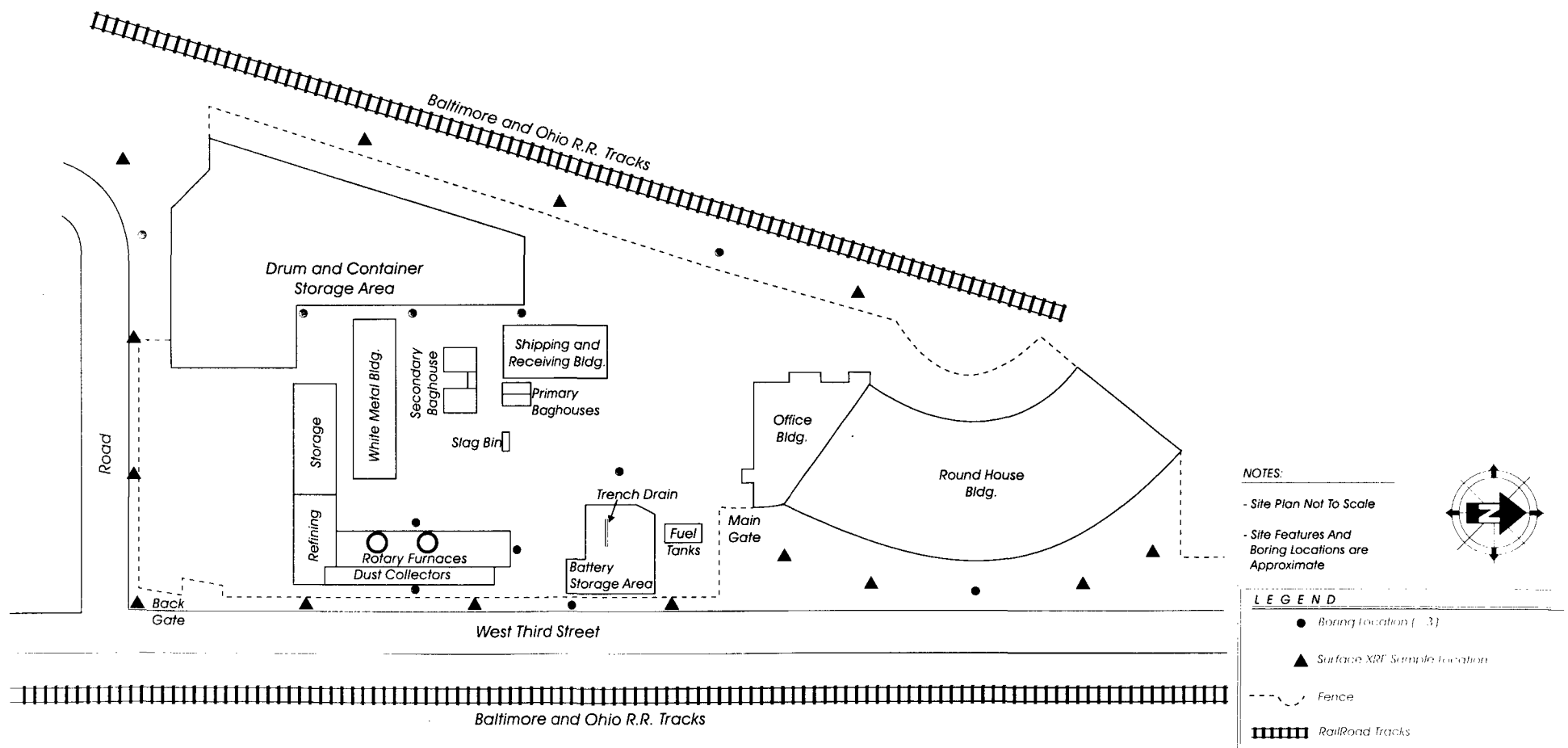
²For XRF analysis, triplicate XRF measurements will be taken at each interval during extent of contamination.

³Metals = arsenic, cadmium, chromium, lead.

Figure 3-1

PROPOSED SAMPLING LOCATIONS

ENTACT
 October 1, 1997

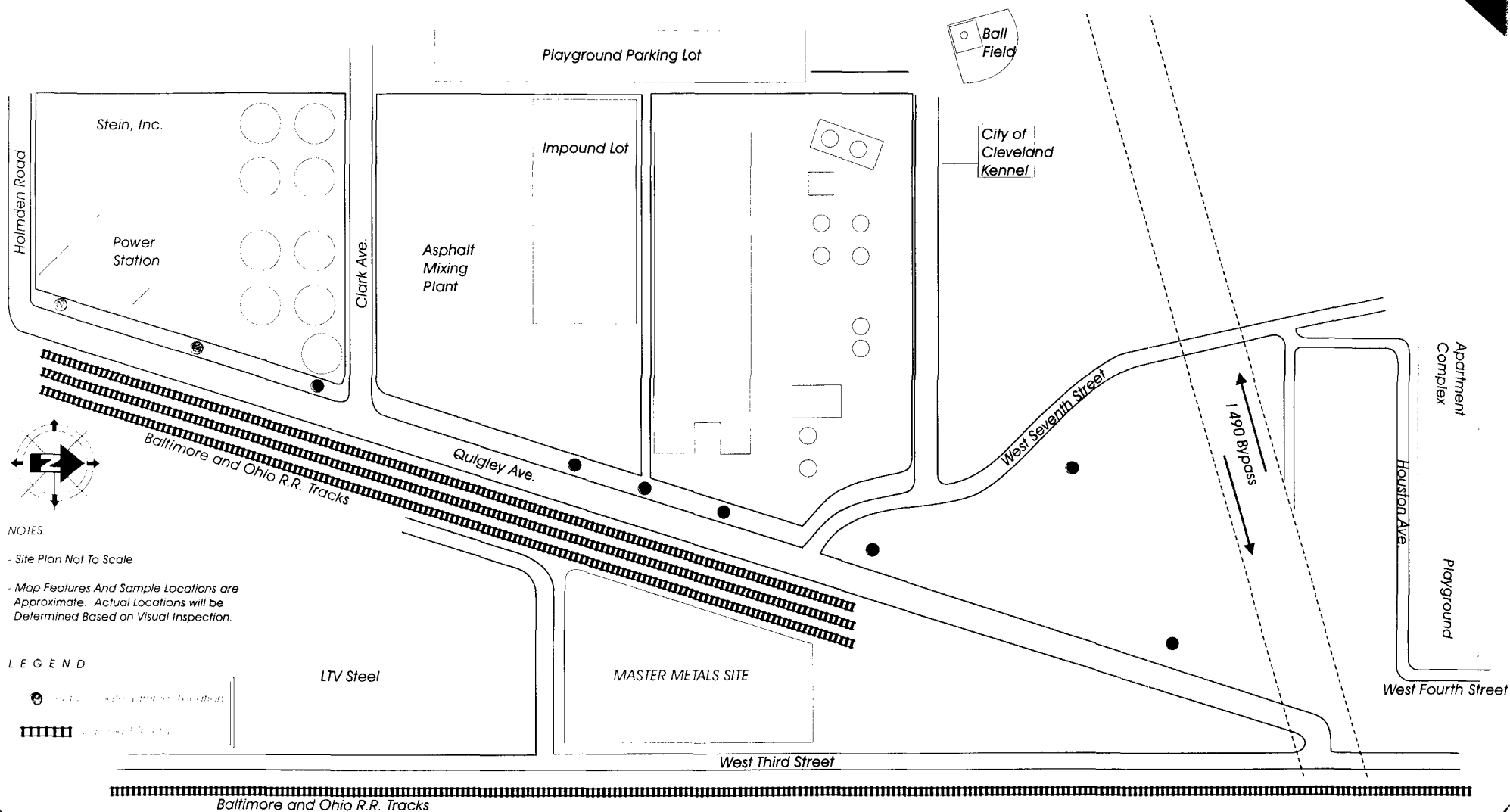


MASTER METALS
SITE
 Cleveland, Ohio

Figure 3-2

AREAS SURROUNDING THE MASTER METALS FACILITY - CLEVELAND, OHIO

ENTACT
 October 1, 1997



NOTES

- Site Plan Not To Scale
- Map Features And Sample Locations are Approximate. Actual Locations will be Determined Based on Visual Inspection.

LEGEND

- Master Metals Site
- LTV Steel

4.0 Project Organization and Schedule

The project organizational chart is provided as Figure 4-1. All management, quality assurance, field and laboratory responsibilities can be found in the Quality Assurance Project Plan (Appendix A - Section 2). The project schedule for the EE/CA is shown in Figure 4-2. It should be noted that the schedule was developed with week 0 corresponding to approval from U.S. EPA and completion of the Phase I time-critical removal.

**PHASE II - EE/CA
PROJECT ORGANIZATIONAL CHART**

ENTACT
October 1, 1997

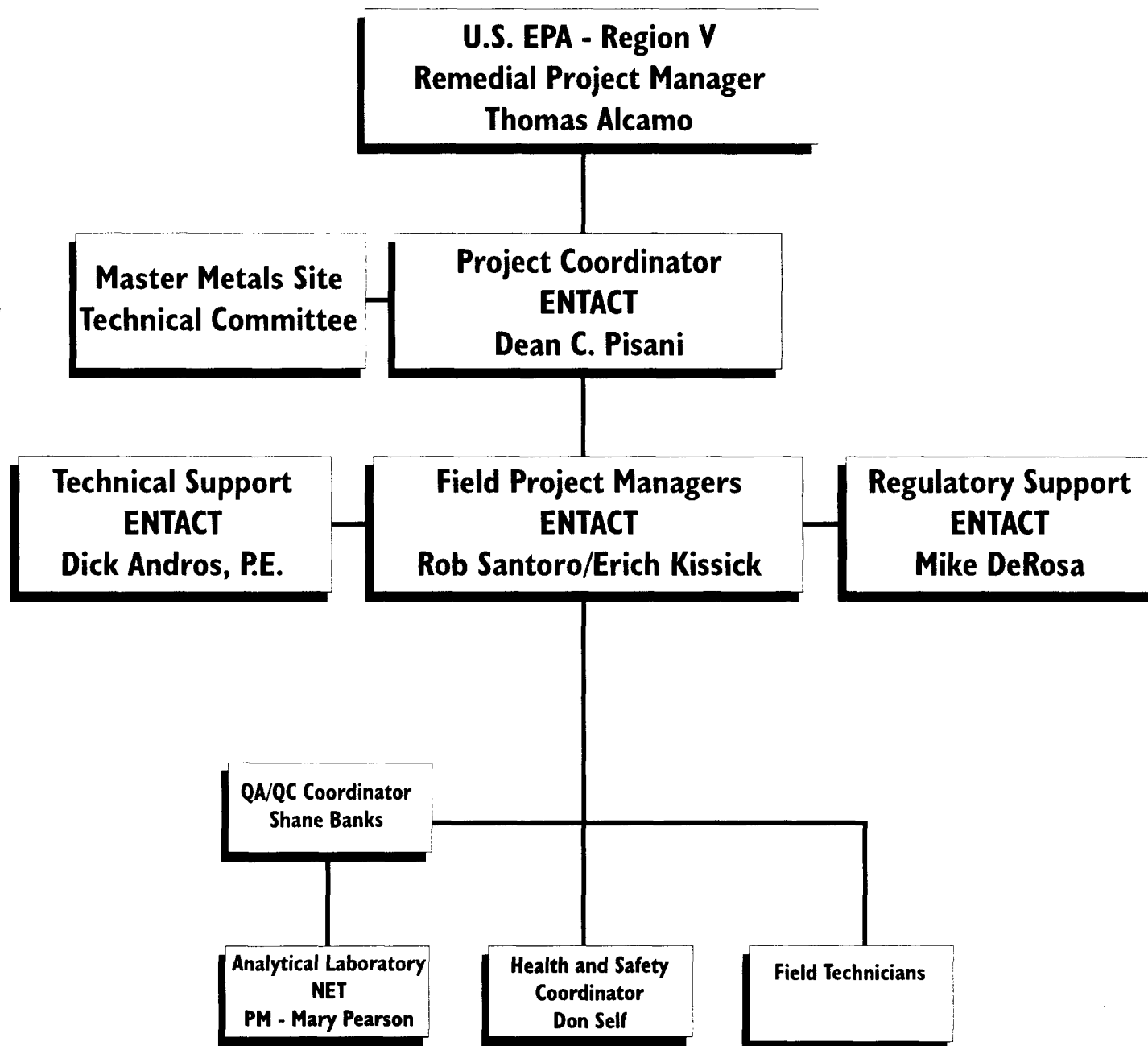
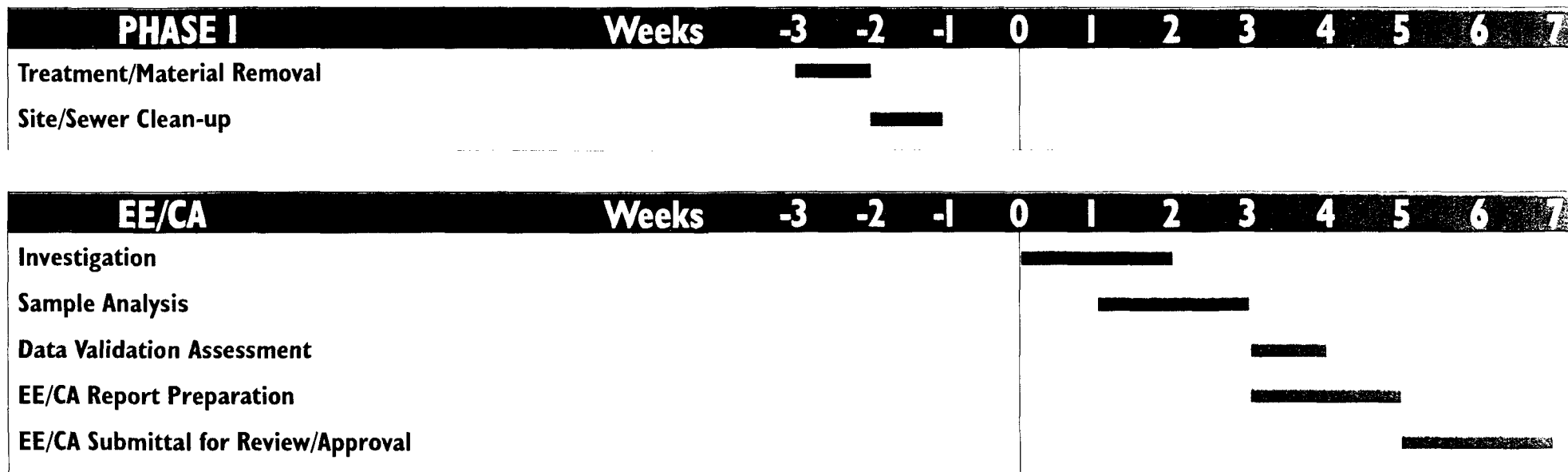


FIGURE 4-1



5.0 Site Health and Safety Plan

A Site Health and Safety Plan was submitted by ENTACT as part of the Phase I Time-Critical Removal Action Plan. The document is hereby incorporated through reference and will be the Health and Safety document for all EE/CA site investigation tasks.

**QUALITY ASSURANCE PROJECT PLAN
TO THE
ENGINEERING EVALUATION/COST ANALYSIS (EE/CA) SAMPLING
WORKPLAN**

**for the:
MASTER METALS SITE
Cleveland, Ohio**

**Prepared by:
ENTACT, Inc.**

October 2, 1997

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1.0 PROJECT DESCRIPTION

1.1 Introduction

This Quality Assurance Project Plan (QAPP), has been developed for the Master Metals Site for use in conjunction with the EE/CA Sampling Workplan and Health and Safety Plan. These documents form the project operation plans intended to guide field personnel, contractors, and other involved parties in all aspects of field operations during this project phase. This QAPP will provide quality assurance (QA) and quality control (QC) procedures for activities to be performed in accordance with the Administrative Order (Order) for the Master Metals Site issued pursuant to Section 106 of the Comprehensive Environmental Response, Compensation, and Liability Act of 1980, as amended 42 U.S.C. §9606(a).

This QAPP will serve as a controlling mechanism during the performance of the sampling and analysis activities to ensure that technical data gathered are accurate, precise, complete, and representative of actual field conditions and meet minimum requirements of the project.

1.1.1 Overall Project Objectives

Overall project objectives for this project phase are fully described in the EE/CA Sampling Workplan and are summarized below:

- ▶ Determine the extent of Master Metals site contamination which resulted from facility operations;
- ▶ Determine contaminant impact of on-site sewer system
- ▶ Develop and implement a site health and safety plan; and
- ▶ Provide and maintain site security and warnings.

1.1.2 QAPP Preparation and Guidelines

All QA and QC procedures described in this QAPP are structured in accordance with

applicable technical standards, EPA requirements, regulations, and guidance. The guidance manual entitled, "Region 5 Model RCRA Quality Assurance Project Plan", May, 1993 was specifically used during QAPP document preparation. Quality assurance (QA) is a management system for ensuring that all information, data, and decisions resulting from the removal action are technically sound and properly documented. Quality control (QC) is the functional mechanism through which quality assurance achieves its goals. In the event there is a conflict in specifications presented herein with those presented in the parent document referencing this QAPP, then the specifications in the parent document will be followed to the extent they are different.

1.2 Site Description

1.2.1 Site Location and Description

The Master Metals Site is located at 2850 West Third Street, Cleveland, Cuyahoga County, Ohio. The site consists of two contiguous parcels totaling approximately 4.3 acres. The property is roughly right triangle-shaped with the southeast corner being the 90 degree angle. The site is bounded on the northwest by railyards owned by the Baltimore and Ohio railroad, on the south by a dead end road, and on the east by West Third Street. The site is enclosed by a ten foot chain link fence. The site is in a heavily industrialized area. LTV Steel owns the property to the north and south of the site.

The Cuyahoga River is approximately 0.5 miles east of the site and flows northward to empty into Lake Erie. Site topographic maps suggest that the direction of groundwater and surface water flow at the facility is northeast toward the Cuyahoga River. The water table is at a depth of about ten feet below the ground surface. Surface soil consists of natural soil developed on either glacial till or river alluvium, and fill material. The fill consists mainly of cinders and slag.

The major features of the site included an office building, numerous storage areas, two baghouses, and a deteriorating smelter building. Currently, only the office building remains

on-site.

1.3 Site/Facility History

1.3.1 General History

Master Metals was a secondary lead smelting facility that produced lead alloys from lead-bearing dross, spent industrial batteries and various other lead scrap materials. In addition, Master Metals recycled flue dust and captured baghouse emissions from its furnace operation. The plant was constructed as a secondary lead smelter in 1932 and was purchased by Master Metals from NL in 1979.

On November 19, 1980, Master Metals obtained interim status to operate certain of the facility's waste piles and treatment units, and a containerized storage area. On November 8, 1985, the hazardous waste piles that contained lead bearing dust (D008 and K069) at the facility lost interim status for failure to certify compliance with financial requirements of 40 CFR 265. The U.S. Department of Justice filed a complaint for violations of RCRA on June 15, 1987 seeking closure of the waste piles and compliance with financial responsibility requirements.

During 1989, the Ohio EPA issued an order that cited Master Metals for emitting smoke from one of its furnaces that exceeded the regulatory limit of 10% opacity and for emitting excessive fugitive dust from both furnaces. The Order required the facility to implement new controls to reduce its emission of particulates and lead. On March 27, 1990, OEPA conducted a hazardous waste inspection and identified seven violations. Thirty-one violations were identified when the OEPA conducted a waste inspection on August 16, 1991.

On August 3, 1992, Ohio EPA ordered an immediate 30 day shut down of the facility because of violations of air quality standards for lead. On August 5, 1993, the OEPA director ordered Master metals to cease operating the facility until it could demonstrate

compliance with air quality standards. These air quality violations were due to lead-laden facility dust migrating off the facility via prevailing winds.

1.3.2 Past and Current Data Collection Activities

In December 1990, Master Metals contracted with Compliance Technologies to install and sample groundwater monitoring wells on the Master Metals site. Analytical results from the four monitoring wells indicated that the surrounding groundwater was contaminated at levels greater than the maximum contaminant levels for lead and cadmium established under the Safe Drinking Water Act.

Analysis of facility soil samples for total metals and pH revealed that the facility soils contained elevated levels of barium, cadmium, chromium, lead, and nickel. The southern portion of the facility near the drum storage area contained concentrations of lead exceeding 10,000 ppm. Elevated lead levels were also discovered near the battery cracking area.

In August 1991, Ohio EPA collected samples of raw materials from the rotary furnace and two waste bins as part of Consent Decree requirements. These samples contained lead concentrations as high as 5,349 mg/L.

In July 1992, U.S. EPA collected through contractor soil samples on and around the facility property to determine if the facility contaminants were subject to airborne transport. Analysis of these samples for RCRA metals and TCLP metals revealed that TCLP lead was present in concentrations more than 200 times the regulatory level of 5 mg/L at all sample locations except for one facility and one off-facility location. Facility soil samples indicate the presence of TCLP arsenic and cadmium, with one location testing at 115,000 ppm for lead. Surface samples collected from off facility locations indicated lead concentrations from 148 to 1,850 ppm.

More recently, ENTACT began decontamination/demolition operations as part of a time-

critical removal at the Master metals site. All buildings except the office building were razed. All remaining feedstock and debris materials were either decontaminated and/or treated and shipped as either special waste or disposed as hazardous waste.

As part of the time-critical removal, all on-site soil areas were excavated to two feet. XRF information collected from the excavations exhibited lead concentrations up to 39,000 ppm in the remaining fill material.

1.4 Specific Project Objectives

1.4.1 Objectives and DQOs

The overall project objectives for the project are summarized in Section 1.1.1. Data Quality Objectives (DQOs) are qualitative and quantitative statements which specify the quality of the data required to support decisions made during project activities and are based on the end uses of the data to be collected. As such, different data uses require different levels of data quality.

DQOs provide a clear definition of the objectives and the method by which decisions will be made. DQOs are developed using the following three-stage process:

Stage 1 - Identify decision types

Stage 2 - Identify data uses and needs

Stage 3 - Design data collection program

The structure of this QAPP and EE/CA Sampling Workplan have complied with the intent of the DQO process. For Stage 1, the decision types have included identification of primary data users, including the Remedial Project Manager, Mr. Thomas Alcamo; the members

of the Technical Steering Committee; and ENTACT, Inc. A review was performed of existing site data from the Site Assessment report by Ecology & Environment, dated August 1992 as well as Master Metals own contractor-derived analytical results. The overall purpose of the Workplan is to perform non-time-critical extent of contamination activities.

Some soil investigation work was performed during the time-critical removal action to determine the extent of soil lead impacts at each on-site soil area and determine appropriate actions levels.

The DQO Stage 2 includes the identification of data uses and needs. Data generated during Phase I will be used to evaluate the exposed soil lead concentrations which may pose a risk to human health. This type of data is primarily soil data. The data quality needs include the appropriate analytical levels and detection limit requirements. Analytical Level 2 will include using the XRF, as well as analysis of the soil characteristics (slag, silt, sand, etc.). Detection limits in the parts per million range are acceptable for Analytical Level 2 given a soil matrix and the expected ranges of solutions.

Soil samples will be taken and analyzed in the laboratory for total lead using Analytical Level 4 requirements. Detection limits in the low parts per million range are acceptable given the soil matrix and expected ranges of solutions. Samples will be analyzed for the parameters and detection limits listed on Table 3-1 of the EE/CA Sampling Workplan. Analytical detection limits and other quality assurance objectives are presented on Table 3-1 of the EE/CA Sampling Workplan.

Field duplicates and rinsate blanks will be taken for field quality assurance (QA) and quality control (QC), as well as laboratory QA and QC to be performed for all samples submitted to the laboratory.

Stage 3 of the DQOs focuses on the data collection program. The data collection program is described in the EE/CA Sampling Workplan and includes use of field logbooks, XRF electronic database, and laboratory analysis reports.

Documentation of the laboratory quality control and conformance with the SW-846 analytical methods will be required during investigation activities. Field duplicates of the laboratory samples will be required at a rate of one (1) duplicate sample for each 10 analytical samples. An equipment rinsate blank will be submitted for every day of sampling.

1.4.2 Target Parameters and Intended Data Usages

The target parameters and test methods for the EE/CA sampling are presented on Table 3-1 and 3-2 of the EE/CA Sampling Workplan. Intended data usages include evaluating extent of lead, arsenic, chromium and cadmium impacts to on and off site soil as well as sampling on-site groundwater (where possible) to provide a comparison with historical groundwater sampling information.

1.4.3 Field Parameters

The intended field parameters include soil sampling for total lead in soil as analyzed by a field portable X-ray Fluorescence Analyzer (XRF) and pH, temperature and specific conductance for on-site groundwater sampling.

1.4.4 Laboratory Parameters

The intended laboratory parameters for this project are presented on Table 3-1 of the EE/CA Sampling Workplan. The parameters include total lead for the evaluation of on-site and perimeter soil samples. Off-site soil samples will be analyzed for total lead. On-site groundwater will be analyzed for total and dissolved lead, arsenic, cadmium, and chromium.

1.4.5 Data Quality Objectives

The intended data quality objectives (DQOs) for this investigation are summarized on Table 3-1 and 3-2 of the EE/CA Sampling Workplan.

1.5 Sampling Design and Rationale

The sampling rationale, fully explained in Section 3.0 of the EE/CA Sampling Workplan is summarized below.

1.5.1 Sampling by Task and Matrix

Sample matrices, analytical parameters and frequencies of sample collection are presented on Table 3-3 of the EE/CA Sampling Workplan.

1.5.2 Site Maps of Sampling Locations

A map showing the intended soil sampling locations is presented in the EE/CA Sampling Workplan as Figure 3-1. It is possible, however, that depending on the nature of encountered field conditions some of these locations will be changed. The person who shall be responsible for making such decisions will be the Project Manager or the Quality Assurance Officer, whose responsibilities are described in Section 2.0 of this QAPP.

1.5.3 Rationale of Selected Sample Locations

The rationale for selected sampling locations is fully described in Section 3.0 of the EE/CA Sampling Workplan.

1.6 Project Schedule

The project schedule is discussed in Section 4.0 of the EE/CA Sampling Workplan. The project schedule is an approximation of time required to complete extent of contamination activities.

2.0 PROJECT ORGANIZATION AND RESPONSIBILITY

ENTACT, Inc. (ENTACT) has overall responsibility for the extent of contamination study at the Master Metals Site. ENTACT will perform the work described in the EE/CA Support Sampling Workplan and prepare the EE/CA report. The various quality assurance, field, laboratory, and management responsibilities of key personnel are defined below.

2.1 Project Organization

The lines of authority for this specific project and a project organization chart are described in Section 4.0 of the EE/CA Workplan. The project organization individuals are discussed below:

2.2 Management Responsibilities

- U.S. EPA Remedial Project Manager (RPM)

The U.S. EPA RPM, Mr. Thomas Alcamo, has overall responsibility for all phases of the investigation/removal. Mr. Alcamo can be contacted as follows:

Mr. Thomas Alcamo
U.S. EPA Region 5
77 West Jackson Boulevard (SR-6J)
Chicago, IL 60604-3590

- Project Management Team

Gary Stevenson, Mike DeRosa, Eric Ward, and Dean Pisani will be the project management team in charge of the work and final completion of the project. They are responsible for ensuring that all project procedures and workmanship conform to regulatory guidelines and accepted engineering practices. All work under this management must be scheduled to allow QA and QC testing personnel to perform their duties. The project management team will delegate and oversee site safety protocol and coordinate emergency responsibilities. Additionally the project management team will be responsible for

maintaining the project schedule or amending as required. ENTACT reserves the right to change the designated project management team. The Project Managers can be contacted as follows:

Project Management Team

ENTACT

1360 North Wood Dale, Suite A

Wood Dale, Illinois 60191

(630) 616-2100

- Quality Assurance Officer

Mr. Eric Ward will be the QA officer and will manage a planned system of inspections and testing procedures to directly monitor and control the quality of the project. All tests and inspections will be completed by him, or someone appointed by him, or outside testing services or analytical laboratories. The QA Officer is responsible for ensuring that all sampling and analysis performed pursuant to this project conforms to the EPA direction, approval, and guidance regarding sampling, quality assurance/ quality control, data validation, and chain of custody procedures. He will also ensure that the laboratory used to perform the analysis participates in a QA/QC program that complies with EPA guidance. All daily activities reports, periodic summaries, measurements and other pertinent activities will be scheduled and managed by him and all information will be reported to the Project Manager.

2.3 Laboratory Responsibilities

- Analytical Laboratory and Laboratory Project Manager

The laboratory to be used for all site sample analyses is National Environmental Testing laboratories (NET) , Bartlett, Illinois. The project manager for overseeing all sample results at the laboratory is Ms. Mary Pearson. She will report to the ENTACT Project Manager or the ENTACT QA Officer. All laboratory analysis will be performed by qualified laboratory

technicians under the supervision of Ms. Pearson.

3.0 QUALITY ASSURANCE OBJECTIVES FOR MEASUREMENT DATA

The overall QA objective for this project is to develop and implement procedures for field sampling, chain-of-custody, laboratory analysis, and reporting that will provide results which are legally defensible in a court of law. The primary goal of the program is to ensure that the data generated meet the project requirements. To obtain this goal, data generated during implementation of the removal action will be evaluated for accuracy, precision, representativeness, completeness, and comparability for both the laboratory analytical program and field sample collection activities. Specific procedures for sampling, chain-of-custody, laboratory instrument calibration, laboratory analysis, reporting of data, internal quality control, audits, preventative maintenance of field equipment, and corrective action are described in other sections of this QAPP.

3.1 Precision

3.1.1 Definition

Precision is a measure of mutual agreement among individual measurements of the same matrix sample type. Precision is assessed through the calculation of relative percent differences (RPD) for duplicate samples. The equations to be used for precision in this Phase I removal action can be found in Section 12.0 of this QAPP.

3.1.2 Field Precision Objectives

Field precision is assessed through the collection and measurement of field duplicates at a rate of 1 duplicate per 10 analytical samples. The total number of duplicate samples is difficult to estimate since it is, in part, dependent upon the actual number of samples submitted for laboratory analysis.

3.1.3 Laboratory Precision Objectives

Precision in the laboratory is assessed by analysis of matrix duplicates or matrix spike duplicates for each batch not to exceed 20 samples.

3.2 Accuracy

3.2.1 Definition

Accuracy is the degree of agreement between a measurement and an accepted reference or true value.

3.2.2 Field Accuracy Objectives

Accuracy in the field is assessed through the use of equipment rinsate blanks, XRF reference standards, and adherence to all sample handling, preservation, and holding times.

3.2.3 Laboratory Accuracy Objectives

Laboratory accuracy is assessed through the analysis of matrix spikes (MS) or standard reference materials (SRM) and the determination of percent recoveries. The equation to be used for accuracy in this project can be found in Section 12.0 of this QAPP.

3.3 Completeness

3.3.1 Definition

Completeness is the amount of valid data obtained from a measurement system compared to the amount that was expected and needed to be obtained to meet the project data goals.

3.3.2 Field Accuracy Objectives

Field completeness is the measurement of the amount of valid measurements obtained from all the measurements taken in the project. The intent of this program is to attempt to achieve a goal of 100 percent completeness. Realizing that under normal conditions this goal may not be achievable, the completeness goal for this program is 90 percent. The equation for completeness is presented in Section 12.0 of this QAPP.

3.3.3 Laboratory Completeness Objectives

Laboratory completeness is a measure of the amount of valid measurements obtained from all the measurements taken in the project. The intent of this program is to attempt to achieve a goal of 100 percent completeness. Realizing that under normal conditions this goal may not be achievable, the completeness goal for this program is 90 percent. The laboratory equation for completeness is presented in Section 12 of this QAPP.

3.4 Representativeness

3.4.1 Definition

Representativeness expresses the degree to which sample data accurately and precisely represent environmental conditions and parameter variations at a sampling location. The Representativeness criterion is best satisfied by assuring that sampling locations are properly selected and a sufficient number of investigative samples are collected.

3.4.2 Measures to Ensure Representativeness of Field Data

Representativeness is dependent upon the proper design of the sampling program and will be satisfied by ensuring that the field sampling plan is followed and that proper sampling techniques are used.

3.4.3 Measures to Ensure Representativeness of Laboratory Data

Representativeness in the laboratory is ensured by using the proper analytical procedures, meeting sample holding times, and analyzing and assessing field duplicate samples. The sampling network was designed to provide data representative of facility conditions. During the development of this network, consideration was given to past operational practices, existing analytical data, physical setting and environmental conditions. The rationale of the sampling network is discussed in detail in Section 3.0 of the EE/CA Sampling Workplan.

3.5 Comparability

3.5.1 Definition

Comparability is a qualitative parameter expressing the confidence with which one data set can be compared to another. Sample data should be comparable with other measurement data for similar samples and sample conditions.

3.5.2 Measures to Ensure Comparability of Field Data

The use of documented and consistent soil sampling procedures will ensure the resulting data are comparable with other similar measurements on similar samples. The XRF calibration procedures described in Section 3.0 of the EE/CA Sampling Workplan ensure consistent, site-specific results.

3.5.3 Measures to Ensure Comparability of Laboratory Data

The use of documented standard laboratory procedures will ensure comparability of results. Similar QA objectives will be used throughout the project to ensure comparability of laboratory generated data.

3.6 Level of Quality Control Effort

Field equipment blanks, duplicates, and standard reference materials will be utilized to assess the

quality of data resulting from the field sampling and analytical programs.

3.6.1 Field Equipment Blanks

Field equipment blanks consisting of distilled water used to rinse decontaminated soil sampling equipment will be submitted to the analytical laboratory at a rate of 1 equipment blank per every ten (10) environmental samples.

3.6.2 Field Duplicates

Field duplicates will be collected and submitted to the laboratory at a rate of 1 duplicate per every 10 environmental samples.

3.6.3 Standard Reference Materials

Laboratory-prepared reference standards are used in the field to standardize XRF equipment on a daily basis.

3.6.4 Laboratory Quality Control

Method blanks, matrix spike duplicate samples, calibration blanks, continuing calibration verification, check standards and surrogates will be performed to assess the quality of laboratory data, where appropriate to the method and/or instrument, in accordance with the approved analytical method.

Method blank samples are generated within the laboratory and used to assess contamination resulting from laboratory procedures. All reagents are added to the blank in the same volumes or proportions as used in sample processing and is carried through the complete sample preparation and analytical procedure. Method blanks will be performed at a rate of 1 per sample batch not to exceed 20 samples.

Matrix spike samples provide information about the effect of the sample matrix on the digestion and measurement methodology. The sample is spiked with a known concentration of target analyte prior to preparation and analysis.

Further, matrix spike samples will be prepared in duplicate to check for analytical precision of a method within the matrix. One set of matrix spike duplicates will be analyzed for every batch of 20 or fewer investigative samples per sample matrix. Instrument calibration checks will be performed in accordance with the approved analytical method.

4.0 SAMPLE PROCEDURES

Sampling procedures for each sample type are fully described in Section 3.0 of the EE/CA Sampling Workplan, including sampling methodology, equipment lists, sample identification, decontamination and sample packaging procedures.

The sampling procedures to be used in this extent of contamination study will be consistent throughout the duration of this project. The SAP outlines all sampling procedure information, including the following information:

- Sample Identification System - Section 3.2
- Sampling Procedures - Section 3.3, 3.4
- Data Quality Objectives - Section 3.7
- Chain of Custody Control - Section 3.8
- Sample Shipping - Section 3.9
- XRF Field Instrument Procedures, Operation, and Calibration - Section 3.10

5.0 SAMPLE CUSTODY AND SHIPPING PROCEDURES

5.1 Custody Procedures

Custody is one of several factors which is necessary for the admissibility of environmental data as evidence in a court of law. Custody procedures help to satisfy the two major requirements for admissibility: relevance and authenticity. Sample custody is addressed in three parts: field sample collection, laboratory analysis, and final evidence files. Final evidence files, including all original laboratory reports, are maintained under document control in a secure area.

A sample or evidence file is under your custody if:

- the item is in actual possession of a person; or
- the item is in the view of the person after being in actual possession of the person; or
- the item was in actual physical possession but is locked up to prevent tampering; or
- the item is in a designated and identified secure area.

5.1.1 Field Custody Procedures

Sample identification documents will be carefully prepared to maintain identification and chain-of-custody records and to control sample disposition. Components of the field documentation procedures include the use of field logbooks, sample labels, and the chain-of-custody forms. Original data recorded in field logbooks, chain-of-custody records, and other forms will be written in waterproof ink. The field sampler is personally responsible for the care and custody of the samples until they are transferred or properly dispatched.

5.1.1.1 Field Logbook Records

A field log of daily activities will be used to record sampling activities on a daily basis. This book will be bound and have consecutively numbered pages. Entries in the field logbook will be made in ink and will include: the name of the author; date and time of entry; location

of activity; names and affiliations of personnel on site; sample collection or measurement methods; number of samples collected; daily weather report; sample identification numbers; field observation and comments; sampling depth increment for soils; field measurements; locations of photographs; and any deviations from the sampling plan. The field log book will be stored in the document control center when it is not in use.

5.1.1.2 Sample Labels

Sample labels are necessary to prevent misidentification of samples. Preprinted labels will be provided prior to the sampling activities. Each label will contain space for the following information: sample location/identification, project number, date and time of sample collection, name of sampler, preservatives, and types of analyses to be performed.

5.1.1.3 Chain-of-Custody Record

A Chain-of-Custody (COC) form will be completed to record the custody of every sample collected. A COC form will accompany every shipment of samples to the analytical laboratory in order to establish the documentation necessary to trace sample possession from the time of sample collection through sample analysis. The sample portion of the COC form will include the following:

- Project number, name and location;
- Sample identification;
- Name of Project Manager, Sampler, and Recorder;
- Sampling information (sampling area, depth, media type, type of sample, date and time of collection, etc.);
- Analysis to be performed;
- Preservatives used, if any; and
- Signatures of persons involved in the COC possession, including dates.

When a Chain-of-Custody form is filled out, one page of the three-part form is retained and placed in a file at the on-site office. The other two parts of the form accompany the sample to the laboratory. One of those pages is retained by the laboratory and the other is returned with the sample result report. When the sample report is received, it is cross-checked with the COC file record and both COC pages and the laboratory report are placed in a file in fireproof storage. The analytical result is also entered into a computer database consisting of a comprehensive list of all samples taken at the site and the analytical results.

5.1.2 Laboratory Custody

NET will be the primary laboratory for all sample analysis. The custody for each sample will be transferred by the signing of the COC record by the receiving laboratory sample custodian. NET maintains strict written protocol for internal sample custody.

Upon receipt of samples, information on the COC shipped with samples will be verified and recorded as to agreement or non-agreement. Labels will be checked for notation of proper preservation. If there is an apparent document non-agreement or incorrect preservation noted, the apparent problem will be recorded and the Project Manager notified. Samples will also be checked for leaking or broken containers. The samples will then be marked or labeled with laboratory sample numbers. Samples will be placed in appropriate storage and/or secure areas to await analysis.

5.1.3 Final Evidence Files

The final evidence file will be the central repository for all documents which constitute evidence relevant to sampling and analysis activities as described in this QAPP. ENTACT is the custodian of the evidence file and maintains the contents of the evidence files for the EE/CA Sampling Workplan, including all relevant reports, records, logs, field notes, pictures, and data reviews in a secured, limited access area under the custody of the ENTACT project manager or central office file manager. At the completion of field activities, all elements of the final evidence file will be transferred to ENTACT's office in Wood Dale,

Illinois.

5.2 Shipping Procedures

For shipping, all samples will be packaged in such a manner as to prevent damage or breakage during shipment or transport. Samples not delivered to the laboratory will be shipped through an overnight parcel service by sampling personnel. Samples will be placed into suitable containers, labeled and sealed in such a manner that tampering with the seal would be obvious. All sample holding times will be tracked and a copy of the Chain-of-Custody form will accompany the samples in a sealed plastic bag.

6.0 CALIBRATION PROCEDURES AND FREQUENCY

Proper calibration, maintenance, and use of instruments and equipment is imperative to ensure the quality of all data collected. A record of calibration and maintenance activities is important to provide legally defensible data.

Instruments and equipment used to gather, generate or measure environmental and physical testing data will be calibrated with sufficient frequency and in such a manner that accuracy and reproducibility are consistent with the manufacturer's specifications. Calibration procedures and frequency of laboratory instrumentation will be specified in the laboratory quality assurance manual.

6.1 Field Instrument Calibration

All instruments and equipment used for the extent of contamination study will be inspected to ensure that the item meets and performs to manufacturer specifications and project specifications. Instruments meeting these requirements are issued to a field technician trained in instrument operation and made available for site use. Field instrument operation and calibration are discussed for the specific equipment in the EE/CA sampling Workplan.

A record of the instrument calibration will be maintained in a bound field notebook and these records will be subject to a QA audit. Information recorded will include the following:

- Date of calibration;
- All data pertaining to the calibration procedures;
- Initials of analyst performing calibration;
- Adjustments made to equipment prior to and following calibration; and
- Record of equipment failure or inability to meet specifications.

6.2 Laboratory Instrument Calibration

The laboratory instruments used during analysis of samples will be calibrated according to and at the frequency indicated by the QA and QC procedures for each testing method used and any additional manufacturer's recommendations. Records of calibration, repair, or replacement will be filed and maintained by the designated laboratory personnel performing analyses and quality control activities. Calibration records of assigned laboratories will be filed and maintained at the laboratory location where the work is performed.

7.0 ANALYTICAL PROCEDURES

7.1 Field Analytical Procedures

Field analytical procedures consist of operation of a X-Ray Fluorescence analyzer (XRF) for soils analysis and pH, temperature, and specific conductance for groundwater analysis. Operational procedures for these instruments are described in the EE/CA Sampling Workplan.

7.2 Laboratory Analytical Procedures

The EE/CA analytical parameters and their specified analytical method are listed in Table 3-1 of the EE/CA Sampling Workplan. NET, Bartlett, Illinois, will analyze all samples in accordance with the specified methods and perform all laboratory calibration checks and quality control checks specified by the methods. NET's Quality Assurance Plan is available upon request.

8.0 INTERNAL QUALITY CONTROL CHECKS

8.1 Field Quality Control Checks

This section describes all specific quality control checks to be addressed for both field and laboratory analysis in order to comply with the requirements of the extent of contamination action. It will include, but not be limited to, the following information.

8.1.1 XRF Instrument

The XRF instrument is standardized daily using site specific reference standards. These reference standards consist of site specific soils and are prepared by an analytical laboratory. The XRF reading of each standard is noted. The XRF will also be calibrated using site-specific soil analytical data as described in the EE/CA Sampling Workplan.

8.1.2 Field Quality Control of Analytical Samples

Field quality control will also be checked by equipment rinsate blanks and field duplicates. These samples were discussed in Section 3.6 of this QAPP.

8.2 Laboratory Quality Control Checks

Laboratory QC checks are accomplished through the use of system checks and QC samples that are introduced into the sample analysis stream. At a minimum, the following laboratory system checks and QC samples for inorganics will be performed.

- Method blank - All reagents are added to the blank in the same volumes or proportions as used in sample processing and is carried through the complete sample preparation and analytical procedure. Method blanks will be performed at a rate of 1 per sample batch not to exceed 20 samples. A batch is a group of samples which are processed as a unit and prepared using the same reagent lot. If a batch exceeds 20 samples, then each group of

20 samples or less will be considered a separate batch.

- Matrix duplicate samples - Intralaboratory split samples which are analyzed to check for analytical precision of a method within the matrix. Matrix duplicates will be performed at a rate of 1 per batch not to exceed 20 samples.
- Matrix spike samples - A sample spiked with a known concentration of target analyte prior to preparation and analysis. One matrix spike will be analyzed for every batch of 20 or fewer investigative samples per sample matrix.
- Instrument calibration checks to be performed in accordance with the approved analytical method being employed.

9.0 DATA REDUCTION, VALIDATION AND REPORTING

All data collected will be reduced, managed, distributed, and preserved in a manner which substantiates and documents that data are of known quality. An outline of the QC data handling process for data collection, reduction, validation, transfer, reporting, and storage for both field and laboratory data is as follows:

9.1 Data Reduction

9.1.1 Field Data Reduction

The main instrument to be used in the field during this investigation that requires field data reduction is the XRF analyzer.

The Spectrace 9000 field portable XRF is a direct read device. However, operational procedures require that the instrument be standardized daily. Site specific matrix reference standards are prepared by an analytical laboratory. Three reference standards for lead are used to standardize the instrument. The standards are stored in XRF compatible plastic analysis cups. Each cup is placed in the analysis chamber and a total lead analysis is performed. The direct read result is recorded in the calibration log book. The reading which is the lowest as compared to the reference standard analyzed is used for the calculation adjustment so that the screening will be conservative.

9.1.2 Laboratory Data Reduction

Raw laboratory data will be recorded in a laboratory notebook along with other pertinent information, such as the sample identification number. Other information to be recorded includes: laboratory procedure used, name of analyst, date of analysis, matrix sampled, reagent concentrations and instrument settings. Copies of any strip chart printouts, such as gas chromatograms, will be maintained on file. The laboratory QA Manager makes periodic reviews of these notebooks prior to final data reporting. Equations to be employed

in data reduction are those outlined in the approved method. Data from laboratory quality control samples will be compared to the method acceptance criteria. Unacceptable data shall be appropriately qualified on the results report. Case narratives will be prepared with information concerning data not within acceptance limits and any other anomalous conditions encountered during analysis. Once this procedure has been completed and the results have been released by the laboratory QA Manager, the data are ready for third party validation.

9.2 Data Validation

Technical data, including field data and results of laboratory sample analyses, will be validated to monitor the performance of the extent of contamination investigation. Procedures for validating field and laboratory data are described below.

9.2.1 Procedures Used to Validate Field Data

Validation of data obtained from field measurements will be performed by the QA Officer. Field data requiring validation includes the daily standardization of the XRF analyzer. The QA Officer shall check the calculation and confirm that the adjusted criteria was used for the total lead field screening activities for that day. Other field validation procedures include a review of log books and proofing data entered into the computer database for transcription errors.

9.2.2 Procedures Used to Validate Lab Data

Under the direction of the laboratory QA Manager, the laboratory will review all analytical data to ensure that results for samples meet all method specified criteria. The requirements to be checked by the laboratory in data validation, as appropriate to the analysis, are:

- Sample Holding Times
- Calibration

- Blanks
- Matrix Spike/Matrix Spike Duplicate
- Field Duplicate
- Target Compound Identification
- Interference Check Sample Analysis
- Compound Quantitation and Reported Detection Limits
- System Performance
- Overall Assessment of Data
- Laboratory Control Sample Analysis

Data which do not meet the quality objectives will be noted. Case narratives will be prepared with information concerning data not within acceptance limits and any other anomalous conditions encountered during analysis.

9.3 Data Reporting

Data generated during these activities will be summarized in a final report. The QA Manager will develop a data storage and information system to facilitate tracking, data calculations, and transfer of data to various forms and reports. Data reporting procedures are as follows.

9.3.1 Field Data Reporting

Data reporting will be performed by the QA Officer and/or Project Manager. All data collected in the field will go through data validation procedures and be put into a database in an organized format so that intermittent and final summaries may be easily generated for data review.

9.3.2 Laboratory Data Reporting

After laboratory data validation, the laboratory will prepare reports which will include at a minimum the following components:

- Sample identification
- Laboratory cross-reference numbers
- Date of issuance
- Analysis method numbers performed
- Results from analyses
- Notation of any data qualifiers

The case narratives, to be prepared in the case of questionable or unacceptable results will include at a minimum:

- Date of issuance
- Project name and number
- Analytical tests performed
- Any deviations from the intended analytical strategy
- Laboratory batch number
- Number of samples and respective matrices
- Condition of samples
- Discussion of holding times
- Discussion of technical problems or observations
- Discussion of quality control checks which failed
- Sample description information
- Analytical results
- Quality control reports
- Description of analytical methodology
- Description of QC methodology
- Signature of Laboratory QC/Operations Manager

Data validation packages to be prepared for 10% of the sample results reported shall include:

- Summary page indicating dates of analyses for samples and laboratory quality

control checks

- Cross referencing of laboratory sample to project sample identification numbers
- Data qualifiers to be used should be adequately described
- Sample preparation and analytical methods
- Sample results
- Raw data for sample results and laboratory quality control samples
- Results of (dated) initial and continuing calibration checks, and GC/MS tuning results, where applicable
- Matrix spike and matrix spike duplicate (if performed) recoveries, laboratory control samples, method blank results and calibration checks

10.0 PERFORMANCE AND SYSTEMS AUDITS

Performance audits and system audits of both field and laboratory activities will be conducted to verify that sampling and analysis are performed in accordance with the procedures established in the EE/CA sampling Workplan and this QAPP. The audits of field and laboratory activities include two independent parts: internal and external audits.

System audits consist of quantitative evaluation of field and laboratory quality control measurement systems to determine if they are used appropriately. These audits may be carried out before all systems are operational, during the program, or after the completion of the program. These audits involve a comparison of the activities presented in the QA plan with those actually scheduled or performed.

Performance audits are a quantitative evaluation of the measurement systems of the program. They require testing of the measurement systems with samples of known composition or behavior to evaluate precision and accuracy after systems are operational and generating data.

10.1 Field Performance and System Audits

10.1.1 Internal Field Audits

Due to the relatively short period of field time for this investigation, the internal field audit tasks will be performed by the Project Manager. The audit will include examination of field activity log books, field instrument calibration and standardizing, sample collection, handling, packaging and chain-of-custody procedures and QA procedures.

10.1.2 External Field Audits

External field audits may be conducted by U.S. EPA representatives at any time during the project and may or may not be announced.

10.2 Laboratory Performance and System Audits

Performance and system audits of both field and laboratory activities will be conducted to verify that sampling and analysis are performed in accordance with the procedures established in the EE/CA sampling Workplan and this QAPP. The audits of field and laboratory activities include two independent parts: internal and external audits.

10.2.1 Internal Laboratory Audits

Internal lab performance audits are usually conducted on a semiannual basis and consist of preparing and submitting blind QC samples along with other project samples. These samples consist of either blind duplicates or field spiked samples. The QA Officer evaluates the analytical results to ensure that the laboratory maintains acceptable QC performance.

Due to the short length of the extent of contamination study, one internal laboratory audit will be conducted by the QA Officer and/or the contractor's corporate office technical coordinator. An internal lab system audit will be performed at least once during the project. The system audit will include an examination of laboratory documentation procedures on sample receiving, sample log-in, sample storage, chain-of-custody procedures, sample preparation and analysis, instrument operating records, etc.

10.2.2 External Laboratory Audits

External laboratory audits may be conducted at any time by U.S. EPA representatives and may or may not be announced.

11.0 PREVENTATIVE MAINTENANCE

To minimize the occurrence of instrument failure and other system malfunctions, a preventative maintenance program for field and laboratory instruments will be implemented. Equipment, instruments, tools, gauges, and other items requiring preventative maintenance will be serviced in accordance with the manufacturer's specified recommendations and written procedures developed by the operators. Maintenance items that cannot be performed by the laboratory technician will be performed by a person certified to repair the instrument. The laboratory will be responsible for performing routine maintenance and will have available tools and spare parts to conduct routine maintenance. A backup XRF unit will be available for use in the case of a malfunction to avoid downtime.

Manufacturer's procedures identify the schedule for servicing critical items in order to minimize the downtime for the measurement system. It will be the responsibility of the field instrument operator and the laboratory to adhere to this maintenance schedule and arrange any necessary and prompt service. In the absence of any manufacturer recommended maintenance criteria, a maintenance procedure will be developed by the operator based upon experience and previous use of the equipment. Service to the equipment, instruments, tools, gauges, etc., shall be performed by qualified personnel.

Logs will be used to record maintenance and service procedures. All maintenance records will be documented and traceable to the specific equipment, instruments, tools, and gauges. Any items found to be inoperable will be taken out of use and a note stating the time and date of this action will be made in the calibration sheets and logs. The reason for equipment failure and the time and date of its return to service will also be noted in the logbook. Records produced shall be reviewed, maintained, and filed by the operators at the laboratories and by the data and sample control personnel when and if equipment, instruments, tools, and gauges are used at the site. The Project Manager will audit these procedures.

12.0 SPECIFIC ROUTINE PROCEDURES USED TO ASSESS DATA PRECISION, ACCURACY, AND COMPLETENESS

This section outlines the QA and QC procedures used in assessing the quality of the chemical data. The data evaluation procedures will be used by the QA Manager for assessing duplicate and/or spike/duplicate spike samples and checking any blank samples that are submitted blind to the analytical laboratories from the field or generated internally by the laboratory, in accordance with this QAPP. The purpose of implementing these procedures is to assess the chemical data generated for accuracy, precision, representativeness, and completeness for both the laboratory analytical program and field sample collection activities.

12.1 Precision Assessment

Precision is assessed by dividing a sample or a spiked sample into equal aliquots. The duplicate samples are then included in the analytical sample set. The splitting of the sample allows the analyst to determine the precision of the preparation and analytical techniques associated with the duplicate sample. The relative percent difference (RPD) between the duplicate samples are calculated and plotted. The RPD is calculated according to the following formula:

$$RPD = \frac{\text{Amount in Sample} - \text{Amount in Duplicate}}{0.5 (\text{Amount in Sample} + \text{Amount in Duplicate})} \times 100$$

12.2 Accuracy Assessment

In order to assure the accuracy of the analytical procedures, an environmental sample is randomly selected from each sample shipment received at the laboratory, and spiked with a known amount of the analyte to be evaluated. A sample spike will be included in every set of 20 samples tested on each instrument. The spike sample is then analyzed. The increase in concentration of the analyte observed in the spiked sample, due to the addition of a known quantity of the analyte, compared to the reported value of the same analyte in the unspiked sample determines the percent recovery.

Daily control charts are plotted for each commonly analyzed compound and recorded. The percent recovery for a spiked sample is calculated according to the following formula:

$$\% \text{ Recovery} = \frac{\text{Amount in spiked sample} - \text{Amount in sample}}{\text{Known amount added}} \times 100$$

12.3 Completeness Assessment

Completeness is the ratio of the number of valid sample results to the total number of samples analyzed with a specific matrix and/or analysis. Following completion of the analytical testing, the percent completeness will be calculated by the following equation:

$$\text{Completeness} = \frac{\text{(Number of valid measurements)}}{\text{(Number of measurements planned)}} \times 100$$

13.0 CORRECTIVE ACTION

Corrective action is the process of identifying, recommending, approving and implementing measures to counter unacceptable procedures or out of quality performance which can affect data quality. Corrective action can occur during field activities, laboratory analyses, data validation and data assessment. All corrective action proposed and implemented should be documented in the regular quality assurance reports to management. Corrective action should only be implemented after approval by the QA Officer or Project Manager.

The following procedures have been established to assure that conditions adverse to quality, such as malfunctions, deficiencies, deviations, and errors, are promptly investigated, documented, evaluated, and corrected. When a significant condition adverse to quality is noted at the site, laboratory, or subcontractor locations, the cause of the condition will be determined and corrective action taken immediately. All project personnel have the responsibility to promptly identify, solicit approved correction, and report conditions adverse to quality. Conditions which warrant corrective action include:

- Predetermined acceptance standards are not attained;
- Procedures or data compiled are determined to be faulty;
- Equipment or instrumentation is found faulty;
- Samples and test results are questionably traceable;
- Quality assurance requirements have been violated;
- System and performance audits indicate problems.

13.1 Field Corrective Action

The need for corrective action will be identified as a result of the field audits previously described. If problems become apparent that are identified as originating in the field, immediate corrective action will take place. If immediate corrective action does not resolve the problem, appropriate personnel will be assigned to investigate and evaluate the cause of the problem. When a corrective action is implemented, the effectiveness of the action will be verified such that the end

result is elimination of the problem.

Corrective action in the field can be needed when the sample network is changed, sampling procedures, and field analytical procedures require modification due to unexpected conditions. In general the QA Officer or the Project Manager may identify the need for corrective action. The field staff in consultation with the Project Manager will recommend the corrective action. It will be the responsibility of the QA Officer and the Project Manager to ensure that corrective action has been implemented.

Corrective action resulting from internal field audits will be implemented immediately if data may be adversely affected due to unapproved or improper use of approved methods. Corrective action will be implemented and documented in the field record book and in quality assurance reports to the entire project management.

13.2 Laboratory Corrective Action

The need for corrective action resulting from QA audits will be initiated by the laboratory QA and QC Manager in consultation with the Operations Manager. The corrective actions will be performed prior to the release of data from the laboratory. The corrective action will be documented in the logbook and submitted to the data validator. If the corrective action does not rectify the situation, the laboratory will contact the ENTACT Project Manager or QA Officer. If the nonconformance causes project objectives not to be achieved, it will be necessary to inform all levels of ENTACT management at the site and the US EPA RPM. Corrective action may include, but is not limited to:

- Reanalyzing the samples, if holding time criteria permit;
- Evaluating and amending sampling and analytical procedures;
- Accepting data with an acknowledged level of uncertainty; and
- Resampling and analysis, if the completeness of the data set or intended use of the data is recognized during a preliminary review to be insufficient to meet program objectives.

13.3 Corrective Action During Data Validation and Data Assessment

The need for corrective action may be identified during either the data validation or data assessment. Potential types of corrective action may include resampling by the field team or reinjection/reanalysis of samples by the laboratory. These actions are dependent upon the ability to mobilize the field team, whether the data to be collected is necessary to meet the required quality assurance objectives (e.g. the holding time has not been exceeded, etc.). The QA Officer is responsible for identifying a corrective action situation, documenting the incident, determining the course of action, and implementing the corrective action.

14.0 QUALITY ASSURANCE REPORTS TO MANAGEMENT

14.1 Contents of a Project QA Report

Analytical results of samples analyzed during the remedial action will be submitted to the Project Leader following a QA and QC review. The results will include a tabulation of the analytical data and an explanation of any field conditions or laboratory QA and QC problems and their effects on data quality. Results of performance audits and system audits will also be included, as appropriate. Proposed corrective action will be recommended in the event that QA problems are identified during review of data quality or results of performance or system audits.

The final report will contain a discussion of QA and QC evaluations summarizing the quality of the data collected and/or used as appropriate to each activity of the project. The objective of the QA and QC summary will be to ensure that the data are representative of site conditions and sufficient in quality and quantity to support the field activities. The QA and QC summary will include:

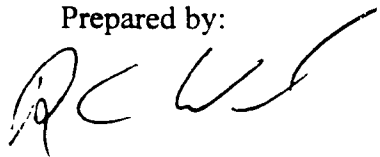
- Tabulated results of all field and analytical data;
- A report from the laboratory QA Manager evaluating the validity of the analytical data with respect to accuracy, precision, completeness, and representativeness; and
- A report from the Project Leader evaluating the results of field and office audits.

A quality assurance report will be prepared by the QA Manager upon receipt of sufficient QA data from the laboratory. The report will be a summary of QA and QC results of the analytical work conducted and will be included as part of the final remedial action report.

ENTACT Inc.

XRF Standard Operating Procedures for Analysis of Soils
Revision I
August 12, 1997

Prepared by:

A handwritten signature in black ink, appearing to read 'R. Eric Ward', with a long, sweeping horizontal stroke extending to the right.

R. Eric Ward
ENTACT Inc.

X-Ray Fluorescence (XRF) Analysis of Soil
Standard Operating Procedures
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I. Principle, Scope and Application

The purpose of this standard operating procedure (SOP) is to serve as a guide for the field analysis of soils for metals. The procedures herein are general operating procedures for the Spectrace 9000 XRF Analyzer or equivalent. They contain detailed procedures for calibration, operation and maintenance of the XRF.

X-radiation of sufficient energy will cause all atoms to fluoresce, emitting x-rays of characteristic energy. By analyzing the fluorescent radiation emitted by a sample under excitation, both the identity and the quantity of the elements present in the sample can be determined.

II. Parameters To Be Measured

A. All metals on the periodic table of elements ranging from Sulfur to Uranium.

III. Range Of Measurement

A. Detection limit (50 ppm -100 ppm) through 300,000 ppm.

IV. Detection Limit

A. The detection limit is variable with each analysis. The detection limit for each analysis is three times the XRF calculated standard deviation.

Example:

The XRF calculated standard deviation is 5 ppm.

$$5 \times 3 = 15$$

The detection limit is 15 ppm.

V. Sample Matrix

A. This SOP is applicable to both in-situ and ex-situ soils and waste.

VI. Interferences and Corrective Actions

A. Lead - Arsenic Interference

1. Interference

Due to the close proximity of the spectra for lead and arsenic, arsenic levels may be masked when the arsenic levels are less than 10% that of lead.

2. Corrective Action

TN Technologies has developed an additional software package for the Spectrace 9000 that will allow the XRF to detect arsenic when levels are as low as 5% that of lead.

B. Moisture

1. Interference

High moisture content (approximately 20% moisture) of muds and sludges can cause erroneous results.

2. Corrective Action

Soils containing high moisture content should be dried prior to analysis.

C. Matrix Effects

1. Interference

Physical characteristics such as particle size and homogeneity can affect the accuracy of the analysis.

2. Corrective Action

Whenever a new matrix is encountered, a sample should be analyzed by both XRF and the laboratory analysis to ensure the XRF accurately analyzes the constituents in the matrix.

D. Placement

1. Interference

If the XRF probe is not placed on a flat uniform soil location errors can result from the distance between the probe and the soil.

2. Corrective Action

Ensure with each measurement that the probe window is placed flat against a uniform flat surface.

VII. Safety Precautions and Emergency Procedures

A. Radiation Levels

According to the Spectrace 9000 users manual, the radiation exposure rate due to the XRF sources with the shutters closed is <0.1 mR/h. In addition, while the shutters are open, the exposure rate remains low provided a sample is completely covering the probe window. The XRF should never be run without a sample over the probe window.

B. Shipment

Under U.S. DOT regulations (49 CFR, 173.422) and International Air Transport Association (IATA), the XRF unit is classified as "Radioactive material, excepted package, instruments, UN2910." As such, the device can be transported by any mode-air, land or sea. It is eligible to be transported in the baggage compartment of a passenger-carrying aircraft. The device is excepted from all specification packaging, marking and labeling. The bill of lading should, however, contain the words: "Radioactive material, excepted package, instruments, UN2910."

C. Storage

ENTACT's XRF units are generally licensed to either the Dallas or Chicago office. The units are to be permanently stored in the office, either Dallas or Chicago, to which it is licensed. The units can be transported to and temporarily (less than 30 days) stored in another state without the state being notified. If it is going to be transported to and stored in another state for longer than 30 days, that state must be contacted to determine the process involved with registering the XRF in that state.

D. Emergency Procedures

1. Secure the area around the incident. Keep unauthorized persons away. Alert people in vicinity of radioactive material and possible hazards.

2. DO NOT LEAVE THE SITE. Send a helper to notify the following persons:

Radiation Safety Officer (RSO): Eric Ward
Work Phone: (773) 281-2455 Pager: (800) 971-2712
Home Phone: (773) 529-0934
and
Local Fire and Police Departments 911

3. The Radiation Safety Officer will provide appropriate notification to:

Illinois Department of Nuclear Safety (217) 785-9000
and
TN Technologies Inc.: (512) 388-9285 or (512) 388-9287

4. The RSO or alternate should inform emergency workers of the potential for existence of a radiation hazard: should help keep the area secure; and should explain to emergency personnel the location of the radioactive device and the extent of the possible hazard. In no case should the response personnel leave the site until qualified experts arrive, unless the worker is seriously injured or incapacitated, and must be removed from the site by emergency personnel.

If Eric Ward cannot be reached, notify Don Self.

Work Number: (972) 580-1323
Home Number: (972) 475-2737

VIII. Sample Size, Collection, Preservation and Handling

- A. The sample size, collection and handling requirements for samples undergoing XRF analysis are determined on a site specific basis. These are to be addressed in the site work plan and quality control plan. The exact requirements will vary depending on the use of the XRF on the site. No preservation is required for soils that are to be analyzed for metals.

IX. Apparatus and Materials

A. Probe

The probe consists of a sealed aluminum enclosure containing a high resolution mercuric iodide detector and three radioisotope x-ray excitation sources. The probe aperture window, through which the analysis is performed, is sealed with thin replaceable film. The probe also contains a pre-amplifier and bias supply for the detector and a mechanism to move the radioisotope sources from their shielded location during an analysis.

B. Electronics Unit

The electronics unit provides data acquisition, processing, and display capabilities. The computer includes a math coprocessor for fast calculation of results. Sufficient memory is available to store up to 300 sets of analysis and 120 spectra. An RS-232 port allows stored data to be transferred to another computer. The graphics display allows direct viewing and qualitative analysis of the x-ray spectra. The replaceable and rechargeable internal battery provides for field portable operation.

C. Additional Parts and Accessories

Additional parts and accessories include: the interconnecting cable, battery chargers, RS-232C interface cable, carrying case, carrying bag, spare battery, analysis stand, Teflon bank and metal standards.

X. Routine Preventative Maintenance

- ENTACT identifies each XRF result with a unique identification number which all routine preventative maintenance to be accomplished as follows:

A. Standardization

The XRF must be standardized by technicians at TN Technologies on an annual basis.

B. Leak Tests

The XRF must be leak tested by technicians at TN Technologies every six months.

C. Source Change

The sources on the XRF must be changed by technicians at TN Technologies according to the following schedule:

Cd-109	2.5 years
Fe-55	5 years
Am 241	never

D. Film change

The film covering the aperture window needs to be changed whenever it is damaged.

XI. Calibration Standards

A. Site Specific Standards

1. Preparation

- a. Collect five soil samples from the site in which XRF analysis will be performed. Use the XRF to guide the collection process. Try to collect samples that vary over the range of total lead levels characteristic of site concentrations.
- b. Transport the samples to the lab and instruct the analyst to perform the following in the order listed for each sample:
 - Dry the samples
 - Grind the samples into a fine powder, removing any rocks or debris
 - Homogenize each individual sample
 - Split each sample. Return one half to ENTACT for use as the standard. Analyze the other half five times for total lead. The lab should then average the results giving a "certified value".
- c. Prepare the site-specific standards using the returned portions of the samples. Place the soil into the XRF sample cups, cover with film and seal. The total lead value of the standard is the average of the five laboratory total lead values.
- d. Use three of the prepared standards to calibrate the XRF. Select one standard below the clean-up criteria, one standard above the clean-up criteria but below the treatment correlation value, and one standard above the treatment correlation value.

2. Storage

- a. The standards must be stored in a manner that will prevent damage to the film.
- b. The shelf life of the site-specific standards is 6 months. Upon expiration of these standards, the standard value should be re-certified by submitting additional sample to the laboratory for re-analysis.

B. Teflon

2. Storage

- a. The teflon standard must be stored in a manner that will prevent damage and contamination.
- b. These standards have an unlimited shelf life.

C. Pure Metal Standards

1. Storage

a. The five pure metal standards (lead, iron, tin, titanium and zinc) standards must be stored in a manner that will prevent damage and contamination .

b. These standards have an unlimited shelf life.

XII. Calibration Procedures

- The following procedures should be performed at the beginning of each days analysis. In addition one site-specific standard to be analyzed for every twenty sample locations analyzed. Finally, at the end of the day all three site-specific standards should be re-analyzed.

A. Instrument Set-up

1. Place the electronics portion of the XRF on a flat surface, adjusting the handle to be used as a stand.
2. Connect the Electronics portion to the probe using the interconnecting cable.
 - a. When inserting the cable into the probe and electronics portion, pull back metal cover on end of the cable, align the red dot on the cable with the grove on the insertion point and finally gently insert the cable until you hear a soft "click".
3. Remove the safety cover from the probe.
4. Place the probe on the lab stand base.
5. Secure the shield cup to the top of the probe.

B. Turn on procedures

1. Turn on the unit.
 - a. Press the "On" button.
 - b. You will then receive the prompt, "Is 0:00:00 the correct time?". If it is the correct time, press "yes" (the number 1 button). If it is not the correct time, press "no" (the number 2 bottom). The XRF will then instruct you on how to reset the time.
 - c. You will then receive the prompt, "Is 0:00:00 the correct date?". If it is the correct date, press "yes" (the number 1 button). If it is not the correct date, press "no" (the number 2 bottom). The XRF will then

instruct you on how to reset the date.

d. Allow the XRF to warm-up for at least 10 minutes.

C. Calibration

1. You are now at the main menu. Select measure (press the number 1 button).

2. You now need to modify the scanning time to allow 50 seconds per source to scan the iron standard.

a. Select “modify” (press the number 1 button).

b. Select “Mod” (press the number 3 button).

c. Enter 50 and press the Cont/Pause button.

d. Select “Down” (press the number 2 button).

e. Select “Mod” (press the number 3 button).

f. Enter 50 and press the Cont/Pause button.

g. Select “Down” (press the number 2 button).

h. Select “Mod” (press the number 3 button).

i. Enter 50 and press the Cont/Pause button.

j. Select “Exit” (press the number 6 button).

3. You are now ready to analyze the iron (FE) standard.

a. Place the iron standard over the source window.

b. Close the shield cup lid.

c. Press the Cont/Pause button.

d. You will now see the label screen.

e. Select the column with “F” in it (press the number 2 button).

f. Select “F” (press the number 6 button).

- g. Select the column with "E" in it (press the number 2 button).
- h. Select "E" (press the number 5 button).
- i. Press the Cont/Pause button.
- j. Select "Opts" (press the number 5 button).
- k. Select "See raw data" (press the number 5 button).
- l. Select "Cd109 33" (press the number 1 button).
- m. Select "Intensities" (press the number 6 button).
- n. Select "Down" (press the number 2 button) until you can read the value for iron (FE). This value should be between 0.98 and 1.02. If it is not, perform an energy calibration. The procedures for an energy calibration are discussed in Section D of this section.
- o. Select "Quit" (press the number 6 button).
- p. Select "Quit" (press the number 7 button).
- q. Select "EXIT" (press the number 0 button).

4. You now need to modify the scanning time for all three sources to measure the Teflon standard.

- a. Select "Measure" (press the number 1 button).
- b. Select "modify" (press the number 1 button).
- c. Select "Mod" (press the number 3 button).
- d. Enter 200 and press the Cont/Pause button.
- e. Select "Down" (press the number 2 button).
- f. Select "Mod" (press the number 3 button).
- g. Enter 200 and press the Cont/Pause button.
- h. Select "Down" (press the number 2 button).
- i. Select "Mod" (press the number 3 button).

- j. Enter 200 and press the Cont/Pause button.
 - k. Select "Exit" (press the number 6 button).
5. You are now ready to analyze the Teflon standard.
- a. Place the Teflon standard over the source window.
 - b. Close the shield cup lid.
 - c. Press the Cont/Pause button.
 - d. You will now see the label screen.
 - e. Select the column with "T" in it (press the number 5 button).
 - f. Select "T" (press the number 6 button).
 - g. Select the column with "E" in it (press the number 2 button).
 - h. Select "E" (press the number 5 button).
 - i. Select the column with "F" in it (press the number 2 button).
 - j. Select "F" (press the number 6 button).
 - k. Select the column with "L" in it (press the number 3 button).
 - l. Select "L" (press the number 6 button).
 - m. Select the column with "O" in it (press the number 4 button).
 - n. Select "O" (press the number 3 button).
 - o. Select the column with "N" in it (press the number 4 button).
 - p. Select "N" (press the number 2 button).
 - q. Press the Cont/Pause button.
 - r. Press the zero button.
 - s. Select "Page down" (press the number 2 button).
 - t. For all results, the result divided by the standard deviation should be

less than five (5). If it is not, acquire new background data. The procedures for acquisition of new background data are discussed in Section E of this section.

6. You now need to modify the scanning times for site specific calibration.

- a. Select "modify" (press the number 1 button).
- b. Select "Mod" (press the number 3 button).
- c. Enter 40 and press the Cont/Pause button.
- d. Select "Down" (press the number 2 button).
- e. Select "Mod" (press the number 3 button).
- f. Enter 10 and press the Cont/Pause button.
- g. Select "Down" (press the number 2 button).
- h. Select "Mod" (press the number 3 button).
- i. Enter 10 and press the Cont/Pause button.
- j. Select "Exit" (press the number 6 button).

7. You are now ready to analyze the site specific standards.

- a. Place one of the site specific standards over the source window.
- b. Close the shield cup lid.
- c. Press the Cont/Pause button.
- d. You will now see the label screen.
- e. Select the column with the first letter or number of your standard name (press the appropriate number button).
- f. Continue this process for the entire standard label.
- g. Press the Cont/Pause button.
- h. Press the zero button.

7. The XRF will return to the analysis screen complete and give further instructions. Follow these instructions until acquisition is complete.

XIII. Sample Preparation

A. In-situ Samples

1. Clear the soil of all vegetation.
2. Clear the soil of any debris that may puncture the aperture window.
3. Tamp the soil to ensure it is flat and free of voids.

B. Collected Samples

1. Dry the samples in an oven or microwave oven.
2. Grind the samples into a fine powder, removing any large rocks or debris.
3. Homogenize the sample to ensure consistency.
4. Place the soil into an XRF soil cup, cover with film and seal.

XIV. Analytical Measurement

A. Instrument Set-up

1. Place the electronics portion of the XRF on a flat surface, adjusting the handle to be used as a stand.
2. Connect the Electronics portion to the probe using the interconnecting cable.
 - a. When inserting the cable into the probe and electronics portion, pull back metal cover on end of the cable, align the red dot on the cable with the groove on the insertion point and finally gently insert the cable until you hear a soft "click".
3. Remove the safety cover from the probe.

B. Turn on procedures

1. Turn on the unit.
 - a. Press the "On" button.
 - b. You will then receive the prompt, "Is 0:00:00 the correct time?". If it is the correct time, press "yes" (the number 1 button). If it is not the correct time, press "no" (the number 2 bottom). The XRF will then instruct you on how to reset the time.
 - c. You will then receive the prompt, "Is 0:00:00 the correct date?". If it is the correct date, press "yes" (the number 1 button). If it is not the correct date, press "no" (the number 2 bottom). The XRF will then

instruct you on how to reset the date.

d. Allow the XRF to warm-up for at least 10 minutes.

C. Field use

1. You are now at the main menu. Select measure (press the number 1 button).
2. You now may need to modify the scanning time.
 - a. Select "modify" (press the number 1 button).
 - b. Select "Mod" (press the number 3 button).
 - c. Enter 40 and press the Cont/Pause button.
 - d. Select "Down" (press the number 2 button).
 - e. Select "Mod" (press the number 3 button).
 - f. Enter 10 and press the Cont/Pause button.
 - h. Select "Down" (press the number 2 button).
 - i. Select "Mod" (press the number 3 button).
 - j. Enter 10 and press the Cont/Pause button.
 - k. Select "Exit" (press the number 6 button).
3. You are now ready for analysis.
 - a. Place one of the sample over the source window or place the probe on the area to be analyze making sure the window is not punctured.
 - b. Close the shield cup lid if applicable.
 - c. Press the Cont/Pause button.
 - d. You will now see the label screen.
 - e. Select the column with the first letter or number of you sample name (press the appropriate number button).
 - f. Continue this process for the entire sample label.

- i. Select "Page down" (press the number 2 button).
- j. Note the value for lead (Pb) or whatever element for which you are analyzing the samples.
- k. Repeat steps c-j for the standard two more times. Each standard should be analyzed in triplicate.
- l. The average of the three values found for the standard should be within $\pm 20\%$ of the known value of the standard. If it is not, perform an energy calibration. The procedures for an energy calibration are discussed in Section D of this section.
- m. Repeat steps a-l for all other site specific standards.

The XRF is now ready to be used.

D. Energy Calibration

- 1. You are now at the Main menu. Select measure (press the number 1 button).
- 2. Select "Options" (press the number 5 button).
- 3. Select "Energy calibration" (press the number 1 button).
- 4. The XRF will then say "Measure Safety Cover".
- 5. Put the safety cover on the probe.
- 6 Select "Proceed" (press the number 1 button).
- 7. The XRF will return to the analysis screen when the energy calibration is complete.

E. Background Data Acquisition

- 1. You are now at the Main menu. Select measure (press the number 1 button).
- 2. Select "Options" (press the number 5 button).
- 3. Select "Acquire background data" (press the number 2 button).
- 4. The XRF will then say "Measure Quartz".
- 5. Put the quartz standard on the probe.
- 6 Select "Proceed" (press the number 1 button).

- g. Press the Cont/Pause button.
- h. Press the zero button.
- i. Select "Page down" (press the number 2 button).
- j. Note the value for lead (Pb) or whatever element for which you are analyzing the samples.
- k. Repeat steps c-j for the standard two more times. Each standard should be analyzed in triplicate.

XV. Data Treatment

A. The result at each sample location is the average of three readings taken at the location.

$$\text{Result} = (\text{Reading 1} + \text{Reading 2} + \text{Reading 3}) / 3$$

B. All readings must be greater than three times the XRF calculated standard deviation in order to be considered valid.

$$\text{Reading} > 3 * \text{Standard deviation}$$

If the above level is not achieved increase the scan time until it is achieved.

XVI. Data Deliverables

- The following documents are available to the client upon request:

A. A summary of initial, ongoing and end of analysis calibration results. This should include each reading, the average of the three readings for each site-specific standard and the percent difference between the result and the laboratory determined value.

B. A logbook detailing the following:

1. Weather conditions
2. Sampler/s
3. Date of analysis
4. Time of each analysis
5. Location of each analysis
6. Sample preparations required
7. Results of each analysis
8. Any problems encountered and corrective actions taken
9. List date of XRF purchase, latest calibration, leak test and source replacement

C. A printout of all results saved on the XRF and downloaded to a PC. This will be downloaded and formatted in EXCEL and will include sample number, date taken and value in ppm.

D. A summary of all QC required. This will be determined on a site specific bases.

XVII. Quality Control Requirements

A. The quality control requirements for the use of the XRF are determined on a site specific basis. These are to be addressed in the site work plan and quality control plan. The exact requirements will vary depending on the use of the XRF on the site. However, all plans should require instrument calibration prior to and after XRF usage.

XVIII. References

A. Spectrace 9000 Analyzer Manual
TN Technologies Inc.
1992, 1993 and 1994

B. Quality Assurance Technical Information Bulletin
US Environmental Protection Agency
Vol.1, No. 4
May 1991